The Delaware County Arboretum: Creating a Space for Learning, Ecology, and Historic Restoration through Arboretum Design

An Honors Thesis (LA 404)

by

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ABSTRACT

The 42 acres of land that currently belong to the Muncie Delaware County Fairgrounds is suffering from erosion, water management issues, and a lack of ecosystem services. Even though the site was originally forested at the beginning of the 1800s, it has since lost over 90% of its trees. Because of this, an investment in restoration and education is vital to improving these native ecological communities. The outcomes of this project are the creation of an arboretum master plan design that restores ecosystem services and biodiversity while also looking 50 years into the future and planning for various disasters, such as droughts or floods that might jeopardize the health of the new site. There is also an educational center located on the site to provide the surrounding community with the tools they need to become better informed about trees and their importance in the landscape.

ACKNOWLEDGMENTS

I would first and foremost like to thank Susan Tomizawa, who was indispensable to me in helping create successful native ecological communities that were both functional systems and aesthetic palettes. She also provided me with resources, inspiration, and critique that pushed my project to become the best it could be. I would also like to thank landscape architect Susan Jacobson from the Morton Arboretum and restoration ecologist Kevin Tungesvick from Spence Nursery for taking time out of their busy schedules to answer my questions about arboretum design and native restoration practices. Lastly, I would like to thank my professors John Motloch and Peter Ellery for guiding me through this final stage of my BLA and helping me prepare for whatever challenges may lie ahead after graduation.

AUTHOR'S STATEMENT

Trees are integral to the survival of the human race; without them, the world as we know it would slowly degrade until it became inhospitable for human life. However, many experts have mounting concerns about the rising count of annual floods; trees are essential to soil conservation and the primary cause of most floods is the deforestation of watersheds, no matter how small they may be. Rain that falls on an unprotected watershed will strike bare ground and beat the soil until it is badly compacted, allowing no water to percolate through to underground aquifers. However, when the watershed is covered by forest, it can retain as much as 35% of the total volume of rainfall in the rich and porous soil. The goal of this project was to take a 42-acre site that had been badly compacted for over 100 years by foot and animal traffic and to create an arboretum in its place. The word "arboretum" comes from two separate Latin words, arbor (tree) and etum (a gathering or collection of), which directly translates to "a gathering or collection of trees."

This particular project was important for me in that it combines my past five years of education and technical skills into a final comprehensive project that could very easily be implemented in the real world. I began in September with the necessary research I would need to fully execute my creative project in the spring. Taking four months to discover what made arboretums unique and why trees especially were important ecological components of healthy ecosystems really opened my eyes to the need for such a design in Muncie, IN.

I then began making inventory and analysis maps in January while also consulting with various professionals about how I should go about designing my site, keeping in mind that I wanted to showcase native ecologies of Indiana on my site. I also used Geographic Information Systems (GIS) maps to look up soil types, watersheds, transportation routes, and vegetation information before I made any design decisions, to be sure that I did not design something hazardous or awkward.

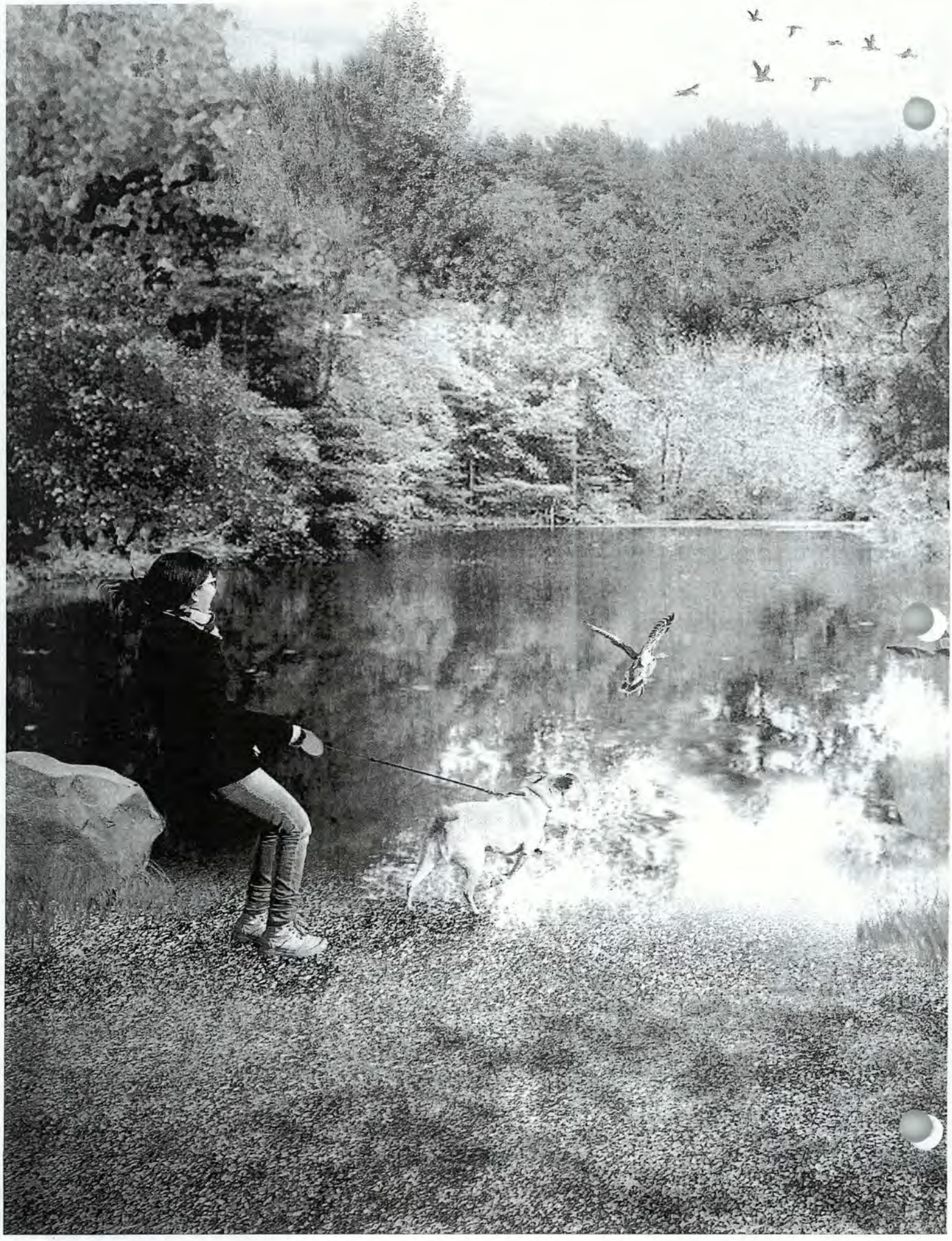
The next stage of my design process came when I started putting

pen to paper and drawing out the various ideas I had for my site. These series of drawings took four to six week s to finalize, including meeting with my mentor every Friday to go over topography decisions, planting palettes, and ecosystem services (or the benefits that plants can have for the general environment and human health). In the end, I drew a final conceptual plan that I then put into AutoCAD (a drafting software) to create my final layout plan with correct dimensions for the visitor's center, children's garden, pathways, and road systems. I this way, I am able to ensure that my dimensions and measurements are up to code and could be implemented in the real world.

One of the more challenging aspects of this project were the various planting plans and palettes for each sections of my site (I created four different zones of planting ecologies. Each palette combines shade trees, ornamental trees, shrubs, ground covers, and ephemerals (spring blooming flowers) in a unique way to support native species of insect, bird, and mammal that may come to visit the site. The blends that I have chosen are also meant to be resilient to Indiana weather and each zone is native to Indiana, making it very sustainable.

The last steps to my project were creating sections and perspectives that conveyed the character of the site and communicated what my final design intent was. Often in the course of a design, these will be the most important drawings because of their ability to speak to the viewer in a way that planting plans and charts cannot. I especially focused on the user experience while they visited the site, including how topography change interacted with the four distinct planting ecologies and how those might be blended together to create a seamless design that looks natural in the landscape.

The final product of this thesis project is a fully integrated and prepared set of drawings that could be handed to a client in a design meeting, ready to be given over to a contractor for revisions. In this way, my creative project is unique in that it combines theory with real world application to create a design that helps and benefits the world around us in a real and tangible way.



Delaware County Arboretum

CREATING A SPACE FOR LEARNING, ECOLOGY, AND HISTORIC RESTORATION THROUGH ARBORETUM DESIGN

Muncie, IN | March 2016

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INTRODUCTION

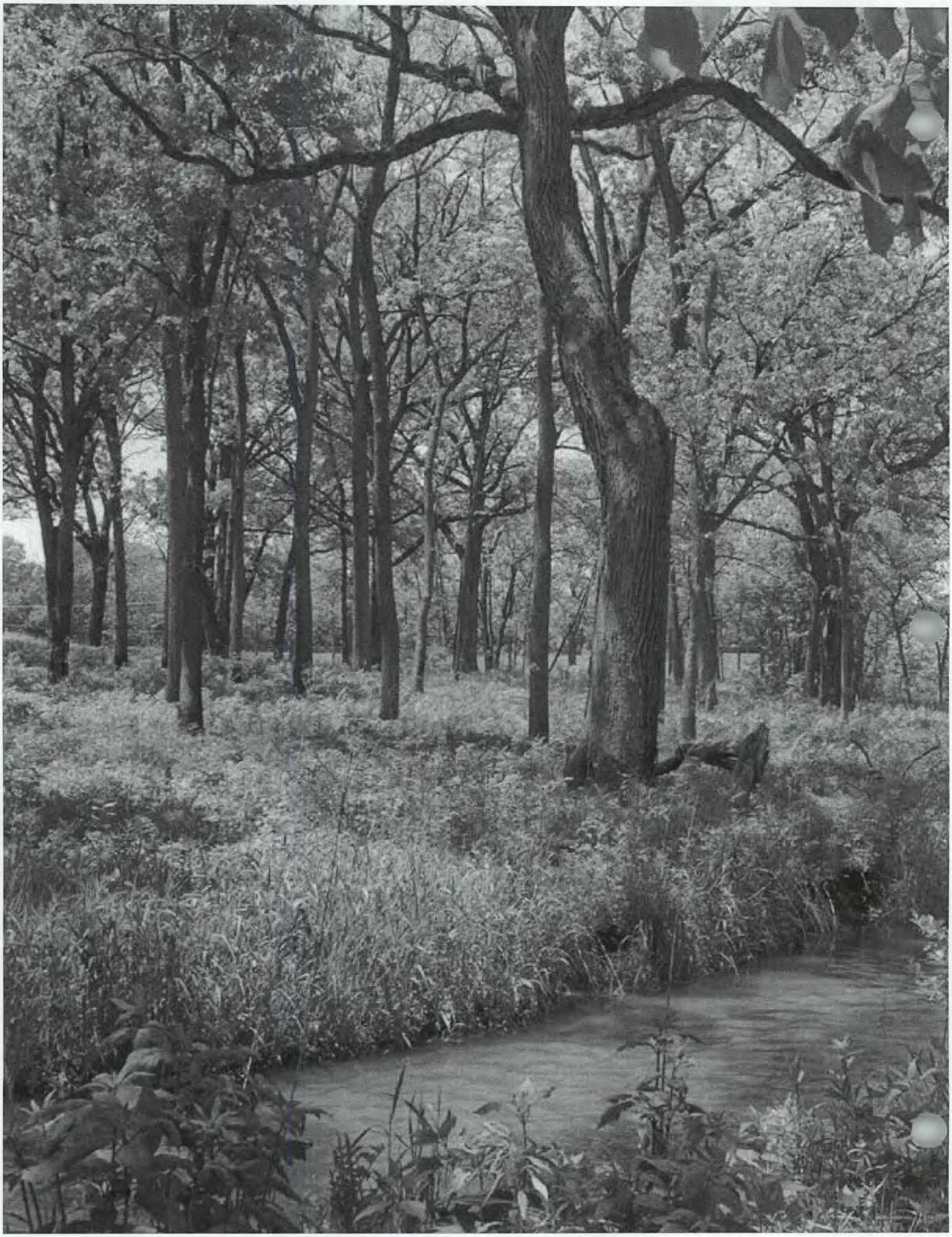
"I said in the beginning that, should the trees die, it is not impossible that man too would become extinct. What then might have seemed a rash and sweeping statement should now acquire new meaning..." Andreas Feininger

The purpose of this project was to create an arboretum for the Muncie community that combined ecological principles of design, such as water retention, erosion control, and invasive plant management, with education. This was in order to increase an awareness of conservation strategies, land management, and environmental balance.

The site chosen for the project was the 42-acres of the current Delaware County Fairgrounds, located east of Ball State University. The fairgrounds have been located at this site for roughly 150 years, which has rendered the soil unsuitable for trees, and has led to an increasing tree mortality rate throughout the years. It has also greatly decreased the biodiversity and wildlife value of the site, which then reflects poorly on surrounding ecosystems.

This proposal was also concerned with the historic nature of the site, looking back at the natural history of the area before human settlement, so that the new site might appropriately respond to the climactic and cultural conditions represented. However, there was also an equal amount of consideration for the site as it stands today and how the current settings might be changed to better enhance the ecosystem services offered, as well as increase the new design's resiliency for the future. Overall, the new arboretum will last for a long time and minimal changes in management will be needed for at least 100 years, unless a calamity of great magnitude degrades what is to be placed there.

The following document includes a problem statement and literature review that covers the history of arboretums and what makes them successful, what the benefits are of a tree-focused arboretum, a discussion of trees in relation to their ecosystem services and site restoration capabilities, and a look at how civic involvement and management practices can make for a long-lasting site design. Also included are the methodologies and conceptual designs employed to work towards the outlined goals and the proposed planting plans, as well as an appendices that includes maps, images, GIS aerial views, and charts to support the listed research. The following designs have been created with special attention to native Indiana ecologies and have the ability to be implemented in the real world.



BACKGROUND

A Comprehensive Look at Arboretums

REVIEW OF LITERATURE

INTRODUCTION

This research is centered on the establishment and design of a tree-focused arboretum that supports local flora and fauna as well as the surrounding community by offering educational, recreational, and ecological opportunities. To fully understand the integration of these factors within the scope of an arboretum, it is first necessary to discover what makes an arboretum successful and how it should be established in relation to the natural heritage of the site. After these have been ascertained, the design will require a careful consideration of why a tree-focused arboretum has more benefits than a simple planted garden space and how it helps increase factors such as biodiversity and habitat. The concept of ecosystem services and site restoration will also be looked at, with a critical observation of how trees can increase biodiversity while also using the SITES guidelines to help ascertain measurable outcomes of a sustainable landscape. Finally, an extended look at management practices and civic involvement will be used to lead to better and more ecologically sound site maintenance for the future that will increase the longevity of the design.

TOPIC: ESTABLISHING A SUCCESSFUL ARBORETUM

Arboretums have been around in America since the early 1800s, influenced by their European predecessors in both style and function (Schlereth 196). The word "arboretum" comes from two separate Latin words, arbor (tree) and etum (a gathering or collection of), which directly translates to "a gathering or collection of trees." Landscape designers such as John Claudius Loudon were important proponents of arboretum design that would be accessible to the general public; his design of Derby Arboretum was a compromise between the idea of a recreational ground for families and community members to enjoy and a botanical garden, though it was not fully open to the public as a free park until after roughly four decades (Wickam 1).

Schlereth also looks back on early North American arboreta that are mostly open to the general public but maintained and governed by a private institution, such as a university (196), which is similar to the proposed management of the new arboretum at the Muncie fairgrounds. Schlereth mentions that these types of arboretums were the first to show up on the North American continent and many have survived to present day, speaking to their resilience and good management, as well as the important role these spaces have played in the communities that surround them. The Arnold Arboretum of Harvard University is a great example of this, having been established in 1872 and still receiving an annual visitor estimation of around 250,000 people (The Arnold Arboretum of Harvard University). Many even introduced crucial species that are key to modern day ecology, such as the highly visual and urban resilient Ginko biloba (Schlereth 201). As arboretums developed, they started including more recreational amenities for visitors, such as open space for play and picnics, as well as educational programs for visitors and research opportunities. For example, an arboretum called "The Woodlands," still located in East Malborough, Pennsylvania today, was embellished with a variety of "recreational and horticultural amenities that made it a favourite

picnic and social gathering site," which added the arboretum's attractiveness once it was opened to the public in 1924 (Schlereth 204-5), a characteristic which is still present in modern day arboretums and is often included in the very beginning design stages.

Authors such as Donald Wyman (1960) and Aldo Leopold (1988) have written on the topic of good arboretum design, citing their beneficial purposes to both historical and present day communities. Arboretums are spaces that should be "carefully planned, well financed, and competently administered" (Wyman 1) if they are to be successful. The National Arboretum Canberra in Australia defines an arboretum today as "a botanical garden devoted to growing trees for conservation, scientific research, and educational purposes," adding that arboreta may specialize in the type of tree they wish to grow, such as a pinetum (conifers), populetum (poplars), and quercetum (oaks) (National Arboretum Canberra). This shows that while arboretums have been around for a while, the definition of what they should do has not changed much. Wyman adds that while arboretums might be considered under the broad umbrella term "park," they are in fact very different. Arboretums make a serious effort to categorize and maintain certain regional characteristics for planted areas, "not only for the purpose of display, but also for critical examination and scientific study...the arboretum or botanical garden go beyond the park in that they become highly educational to many for their visitors, demonstrating by means of labeled specimens what good species are available for planting in a given area or can be grown indoors" (Wyman 1).

While many arboretums may boast tropical and international collections, in the end these types of plants will not survive or contribute fully to the functioning of the local arboretum, for "the purpose of any arboretum, be it large or small, is to grow...wood plants which will thrive in a given locality" (Wyman 1). The best arboretums are those that speak to the local character of the place, just like the management team at the Wisconsin Arboretum did: "Our idea, in a nutshell, is to reconstruct, primarily for the use of the University, a

sample of original Wisconsin" (Leopold 1). Wyman establishes a list of purposes and functions for successful arboretums, which include:

- Showing a complete selection of what is considered the best from a standpoint among woody plants for what is possible to be grown in the area (1)
- Serving as a means to disseminate knowledge of the plants to the general public, including information on culture, pruning, fertilizing, and including cooperation with schools, garden clubs, and other organizations (1)
- To grow a few of the best hardy plants of the area so that local homeowners may become acquainted with their names and the proper ways in which to take care of them (1)
- To provide "recreational stimulus" in the form of walks, informal drives, and beautiful displays in order to stimulate interest in learning about native plants that might then be planted on local property (2)

Wyman also includes considerations based on the needs and desires of the people, such as including an extensive display greenhouse for winter or the functions of certain display gardens (i.e. scientific or purely ornamental) depending on community funds and size.

A more modern day example of successful arboretum design can be found in the "Design Principles, Design Guidelines, and Standing Review Committees for the Arboretum at Penn State," which outlines the design principles that the designers were to consider in the framework plan of the arboretum, including:

- Open and porous edges, inviting members from campus and the surrounding community and facilitating accessibility (2)
- Responding to the cultural traditions and natural heritage rooted within central Pennsylvania and including design elements that respond to regional and local character (2)
- Serving as a metaphor for the environmentally compatible use of the natural landscape by humans and distinctly defining three zones within the arboretum itself
- Emphasizing four interpretive themes: 1) Richness of biological and ecological diversity 2) Stewardship and conservation of soil,

water, and biological resources 3) Demonstration of environmentally sound and responsible landscape design 4) Restoration of degraded landscapes, where applicable (2)

- Designing to enhance and contribute to the educational and research missions of the arboretum (2)
- Grounding all development within the arboretum in practices of stewardship, conservation, and preservation (2)

Other, more detailed management and design practices are included in the report, such as water conservation and management, specific educational programs and infrastructure, plant selection, circulation, materials, as well as additional recommendations that would provide oversight in the design and development to ensure design integrity (Berghage 6).

While looking at arboretums in general and what would make them successful, it is also important to review the natural heritage of Muncie, Indiana, in order to more specifically tailor a design that would flourish and grow well within the community, with the end goal being a design that would inspire regional character and a sense of stewardship. Marion Jackson defines the bioregion that Muncie resides in as "The Central Till Plain Natural Region," an area where flat woods, or forests that occur on relatively flat land with poorly drained soil, dominate (195). Before settlement, this region of Indiana used to be heavily forested, with tree species such as beech, maple, oak, ash, and elm (195). Because of this, an arboretum consisting of the listed tree species would most likely benefit the Muncie fairgrounds site the most, as well as providing the opportunity to the surrounding community to engage with Muncie's natural heritage in an interactive way.

These suggested design principles, though some are from a more dated source, are relevant to the present design of arboreta because they adhere to the current guidelines of an arboretum as outlined above: to create a public space that invites the public to interact with nature while learning about the importance of trees in urban environments and how they might apply similar principles in

their own landscape management, as well as gaining knowledge of Muncie's past natural heritage.

TOPIC: WHY TREES MATTER AND THEIR ROLE IN ADAPTATION

"I said in the beginning that, should the trees die, it is not impossible that man too would become extinct. What then might have seemed a rash and sweeping statement should now acquire new meaning" (Feininger 14). Glass et al. (2009), Manning et al. (2009), and Toomer (2015) have stated their concern over arboretum management and current trends of climate change, looking to new methods of ecological restoration and management, as well as citing the good yet intangible qualities that trees provide (Feininger 1991). Rapid climate change is having a large impact on biodiversity, forcing species to shift their ranges and mature trees to decline, as well as watersheds to flood more easily (Manning et al. 915; Stagoll et al. 115). Though many approaches to adaptation have been suggested, such as assisted colonization, increasing the number of parks and reserves, and enhancing connectivity, "it is unlikely that any individual approach alone will be successful in facilitating adaption, not least because organisms are expected to respond individualistically," (Manning et al. 915-6).

Feininger voices a mounting concern about the rising count of annual floods; trees are essential to soil conservation and the primary cause of most floods is the deforestation of watersheds, no matter how small they may be (10). Rain that falls on an unprotected watershed will strike bare ground and beat the soil until it is badly compacted, allowing no water to percolate through to underground aquifers (Feininger 12). However, when the watershed is covered by forest, it can retain as much as 35% of the total volume of rainfall in the rich and porous soil (Feininger 12). Manning adds in his article that continuous sparse cover could allow for an even distribution of the ecological value of trees, such as water balance, shade, shelter, and foraging spaces (917). "An important large-scale strategy for facilitating adaptation will be a shift from protected-only approaches to 'ecological networks' including

protected areas, corridors, and surrounding landscapes that will provide connectivity across landscapes" (Manning et al. 917). Malitz adds that although some trees may be disease prone and may die off, "they tend to send up new growth from the roots, providing a constant source of renewal for those that are used up" (147).

I have proposed that the new arboretum be constructed with a 100-year plan in mind, guaranteeing that the new systems will last beyond a generation and will contribute to the Muncie ecosystem in a continuous and long-term fashion. I also plan to look at disaster scenarios and how the site might be designed to mitigate those issues. One way to achieve a long-term advantage is by the use of trees in a natural arboretum setting instead of creating a manicured botanic garden, thereby promoting management practices where "less is more." One advantage to this method, as noted by Malitz, is that a broken tree branch, mismatched groundcovers, and even a few weeds can be overlooked because of the informality of the design, therefore making it fairly easy to maintain (147). A natural forest setting is also conducive to groundcover use instead of large open laws, a practice that reduces water use and keeps the maintenance manageable (Malitz 147-8). The ease of maintenance will allow for the more important aspects of the site to be looked after, such as specific tree mortality rates and a constant count of disease and rot to be taken care of, lending longevity to the overall system in place.

This paragraph deals with increasing biodiversity)Trees, especially mature urban trees, provide critical habitat for a wide range of species, as well as offering resources and shelter for a "range of taxa" and are important socially, culturally, and aesthetically (Stagoll et al. 115; Malitz 148). Stagoll et al. further emphasizes that "large trees fulfill a range of landscape-scale ecological functions, including increasing habitat connectivity, which may facilitate species' range expansions and thus capacity to adapt to climate change" (115). Stagoll and his colleagues recognized that research into trees as "keystone structures" in urban landscapes was "urgently needed," so they conducted a study that observed the role of large

native trees for birds in urban parks in Canberra, Australia (115). They found that large trees had a consistent and very strong relationship with measures of bird diversity and that as trees became larger, their positive effect on bird diversity increased (115). This points to the ongoing importance of large tree maintenance in urban parks, as well as the addition of new plantings that will increase the positive effects in the area. Malitz is also quick to point out that "even a small garden forest quickly becomes a wildlife sanctuary" (148). The planting of an arboretum would accomplish both these goals, while also educating the general public about the importance of research results such as these.

It is important when considering the benefits of trees in the landscape to look at their potential adaptation qualities to various environmental issues as well. One approach to adaptation that would work well within the scope of this project are scattered tree elements, which "occur in natural landscapes, culture landscapes and recently modified landscapes worldwide (Manning et al. 916). Scattered trees are recognized as "keystone elements" that provide important ecological values, including the conservation of soil nutrients, focal points for tree regeneration, increased vegetation structural complexity, and habitat provision (Manning et al. 916). Because the current site of the Delaware County Fairgrounds sits atop a landscape that has been modified from a denser and more intact woodland, leaving a portion of the site to act as this key defining feature would be crucial in influencing "'landscape fluidity' (the ebb and flow of different organisms within a landscape through time)" (Manning et al. 916). This method would also provide a starting point to restore the rest of the site by letting this first wave of trees establish themselves, and then subsequently planting newer generations after the soil has become somewhat recovered.

The ecological role of trees is hard to be ignored, showing that the implementation of an arboretum on the current site of the Muncie Delaware County Fairgrounds would benefit not just local ecosystems but also the surrounding community. With various adaptation scenarios

being discussed by Manning et al. and Malitz, such as scattered trees that provide "keystone elements" to the landscape or the benefits of a forested area related to simpler and more efficient management techniques, the proposed arboretum design will respond to the sites specific needs for biodiversity, sustainability, and longevity to create an environmentally conscious and well-thought out plan.

TOPIC: SITE RESTORATION AND ECOSYSTEM SERVICES

While the positive effect of trees on biodiversity and their adaptation to problems such as climate change is apparent, Windhager et al. notes that "environmental design has a long history of concern for ecosystems but has often lacked explicit assessments of, or goals associated with site performance" (107) for landscapes that are degraded or have been restored. The issue that is often encountered is the non-direct ways in which ecosystems perform or what their measurable output is or will be. An increasing amount of literature is talking about the concept of "ecosystem services," which have the ability to provide a balance of social equity, environmental quality, and economic efficiency in a measurable way (Windhager, et al. 107). Examples of ecosystem services range from the erosion control that groundcover provides during heavy rainfall to more indirect benefits, such as recreation, human health and mental wellbeing, and a sense of place (Sustainable Sites Initiative). Many authors, including Windhager et al. (2010), Rigg (2001), Benayas et al. (2009), and the Sustainable Sites Initiative (2015) have discussed the benefits of ecosystem services and the tangible benefits they provide, especially when implemented at regional and local scales. By applying the concept of ecosystem services discussed by Benayas et al., Design Workshop, and the SITES website in the following paragraphs at the local scale of the Muncie Delaware County Fairgrounds, the consideration of how an arboretum as a restored landscape on a degraded site will contribute to the welfare of the site and surrounding community can be fully investigated.

Rigg notes in her article "Orchestrating Ecosystem Management:

Challenges and Lessons from Sequoia National Forest" that public opinion is pressuring governments to shift from a commodity-based resource mindset to a management mindset directed at sustaining dynamic ecosystems, calling for the ecological restoration of many areas that have been degraded by the likes of deforestation or overgrazing (79). For the purpose of this research, Benayas et al. defines ecological restoration as "the reestablishment of the characteristics of an ecosystem that was present before degradation" (1122), which includes factors such as hydrology, soil erosion, shade, and invasive species control or elimination. Restoration activities are globally supported, with policy commitments and framework plans such as the Convention on Biological Diversity being created, whose objective is to conserve biological diversity, as well as promote "the sustainable use of its components and the fair and equitable sharing of the benefits arising out the utilization of [these] resources" (Convention of Biological Diversity). The global support of these commitments to biodiversity and utilizing their ecosystem services shows a greater shift towards healthy ecosystem management, as well as a way to define and measure what those benefits can offer to businesses and surrounding communities.

Roberts et al., who writes an article in Ecological Applications, defines biodiversity as the "diversity of life in all its forms and all its levels of organization, including the ecological structures, functions, and processes at all of those levels" (969). Though the relationship between biodiversity and the provision of ecosystem services has been the focus of major research attention in past years, Benayas et al. notes that the certainty of such a relationship remains unclear, as long-term studies are rarely carried out by ecologists and when they are there is often not enough funding to gather the appropriate evidence (1122). Because of this, Benayas et al. went on to provide a meta-analysis of 89 published scientific assessments of the outcomes of restoration actions in a variety of ecosystems, attempting to showcase what the relationship between degraded and restored landscapes might be and what kind of measurable benefits could be found (Figure 5.1) (1122). Their results indicated that ecosystem services and biodiversity

were higher in restored than in degraded systems at 125% and 144%, respectively (1122), suggesting that any type of restoration is beneficial to landscapes that are under performing from various ailments, such as invasive species, over-grazing, or hydrological disruption.

One such site that suffered from severe degradation but was then restored is the Houston Arboretum and Nature Center. Between the years 2008 and 2011, Texas was battered by Hurricane Ike and then experienced the worst drought on record. Because of these two extremes, significant damage and tree mortality was seen at the arboretum, reducing the vitality of the 155-acre site to half of what it had been (Design Workshop). As a result, Design Workshop was called in to create a sustainable master plan, which has restored historic prairie, savanna, and woodland ecosystems, as well as ensuring "true ecosystem restoration" by considering soil and drainage influences that will create a resilient site against severe drought and hurricanes (Design Workshop). The hope is that within 20-30 years, tree cover will be restored over 70% of the site (Design Workshop).

Benayas et al. also looked at reference systems (that had never been degraded and remained in a natural state) versus restored systems, wondering if they would be the same (1122). While they found that the biodiversity and ecosystem services in restored systems were only 51-59% that of reference systems, they concluded that a restored system verses a degraded one was infinitely more beneficial (1122). The results also indicated that at national, regional, and local scales, ecological restoration was likely to lead to larger increases in biodiversity and ecosystem services, which coincides with Roberts et al. and their conclusion that "managers should manage locally for regional diversity" (970).

The Sustainable Sites Initiative, or SITES, was created to help with this management at local and regional scales. The SITES website defines the SITES Initiative as an interdisciplinary effort to develop guidelines and a voluntary rating system for sustainable land design, construction, and maintenance, while also being an authoritative source for guiding and certifying sustainable landscapes based

on the concept of ecosystem services and the encouragement of biodiversity. The SITES Initiative looks at direct influences of ecosystem services, such as erosion control and shade coverage, while also looking at more indirect influences, such as the cultural, educational, and aesthetic values of a site, supporting the ideas put forth by Windhager et al. (2010), Rigg (2001), and Benayas et al. (2009) by advocating to protect, improve, and regenerate the benefits and services provided by healthy ecosystems.

A main cornerstone to the ideas supported by SITES is the idea of regenerative design, which is defined as a "step-by-step framework for approaching existing site elements in order to preserve, manage, restore, or generate high functioning ecosystems and increase landscape performance" (SITES Website). The four steps, in hierarchical format, are as follows (Figure 5.2):

- Conservation-If the existing conditions of soil, vegetation, and habitat on site are found to be healthy and functional, preservation and management of these systems should take place to maintain their long term health and vitality, including properly protecting and maintaining during site design and construction (SITES Website)
- Management-Action against invasive species (who contribute to a loss of ecosystem function and biodiversity) should be taken to remove and appropriately manage to prevent spread and colonization throughout the site (SITES Website)
- Restore-Degradation from previous development should be addressed during project development so that performance benefits are regained (SITES Website)
- Generate-If existing features are lacking, development techniques should be applied, such as rain gardens, native plantings, and green roofs, ensuring a future landscape with high ecological performance (SITES Website)

The SITES website provides a database of useful projects that have already been implemented and rated according to the rubric provided by the SITES certification system, including the Morton Arboretum parking lot and Meadow Lake site. Goals included improving water

quality, stabilizing the embankments with well-rooted plants, and providing visitors with a successful example of best management practices within an arboretum setting; the SITES principles are also influencing the planning of "future capital improvements to the 1700-acre arboretum grounds" (SITES Website). Considering that the Morton Arboretum has been established for almost 100 years, this will provide beneficial information about arboretum design and sustainable management, as well as providing a framework plan for the beginning stages of the new Muncie arboretum.

TOPIC: MANAGEMENT PRACTICES AND CIVIC INVOLVEMENT

After the proposed arboretum has been constructed, there are still many factors to consider, including ecosystem management, specifically ecologically sound forest management, which Roberts et al. says should be "based on an understanding of natural patterns of diversity and the ecological processes that influence these patterns" (969). Rigg follows along the same vein as Roberts et al., defining the characteristics of ecosystem management to include the following: ecological and integrated systems management, adaptive scientific management, cooperation and collaboration, and integration of social values into management decisions, claiming that "these themes are umbrella concepts consistently identified in the literature, irrespective of author affiliation or organizational bias" (Rigg 81). While regenerative design is informed through previous studies of undisturbed landscapes, ecosystem management involves reconciling the conflicting relationships between social, political, economic, biological, physical, and ecological variables that will be present after the site has been constructed (Rigg 87).

While ecosystem services, biodiversity, human health, regenerative design, and landscape performance are intrinsically involved in the design process and are integrated with ecologically sound management, the conversation about collaborative management and clearly defined leadership roles in the civic realm often take a back seat, which can lead to project difficulties and

even cancellation. In order for the proposed arboretum to continue successfully well into the future, there needs to be room for civic engagement and collaborative environments to foster. Rigg highlights the fact that collaborative management is repeatedly identified as fundamental to the success of ecosystem management and that therefore "motivated individuals in both the agency and the public must continuously reinforce their commitment to and confidence in the process and must establish a stable group with sincere and effective leadership" (84). Rigg goes on to say that interactions between collaborative partners should start early and continue throughout decisions-making process, while clearly defined rights, needs, roles, desires, and responsibilities among groups will reconcile any perceived communication difficulties (84), which can help move a project along and keep it from getting canceled. "These measurable outcomes and access to information are necessary to achieve trust and sustain public interest and participation in the process" (Rigg 84).

The site design of the Muncie Delaware County Fairgrounds arboretum will apply the regenerative design principles listed above, in order to enhance human well-being, as well as strengthen the community by reconnecting humans to nature, improve human health (physical, mental, spiritual) and foster stewardship and education about regional flora and fauna. Since strong connections have been made between the value of ecosystem services and an increase in biodiversity, the design for the future arboretum will take a critical look at best design practices and will seek to provide tangible benefits that address both direct and indirect site improvements. There will also be considerations into future ecological management practices recommended by Roberts et al. (1995), Rigg (2001), and the Sustainable Sites Initiative (2015).

CONCLUSION

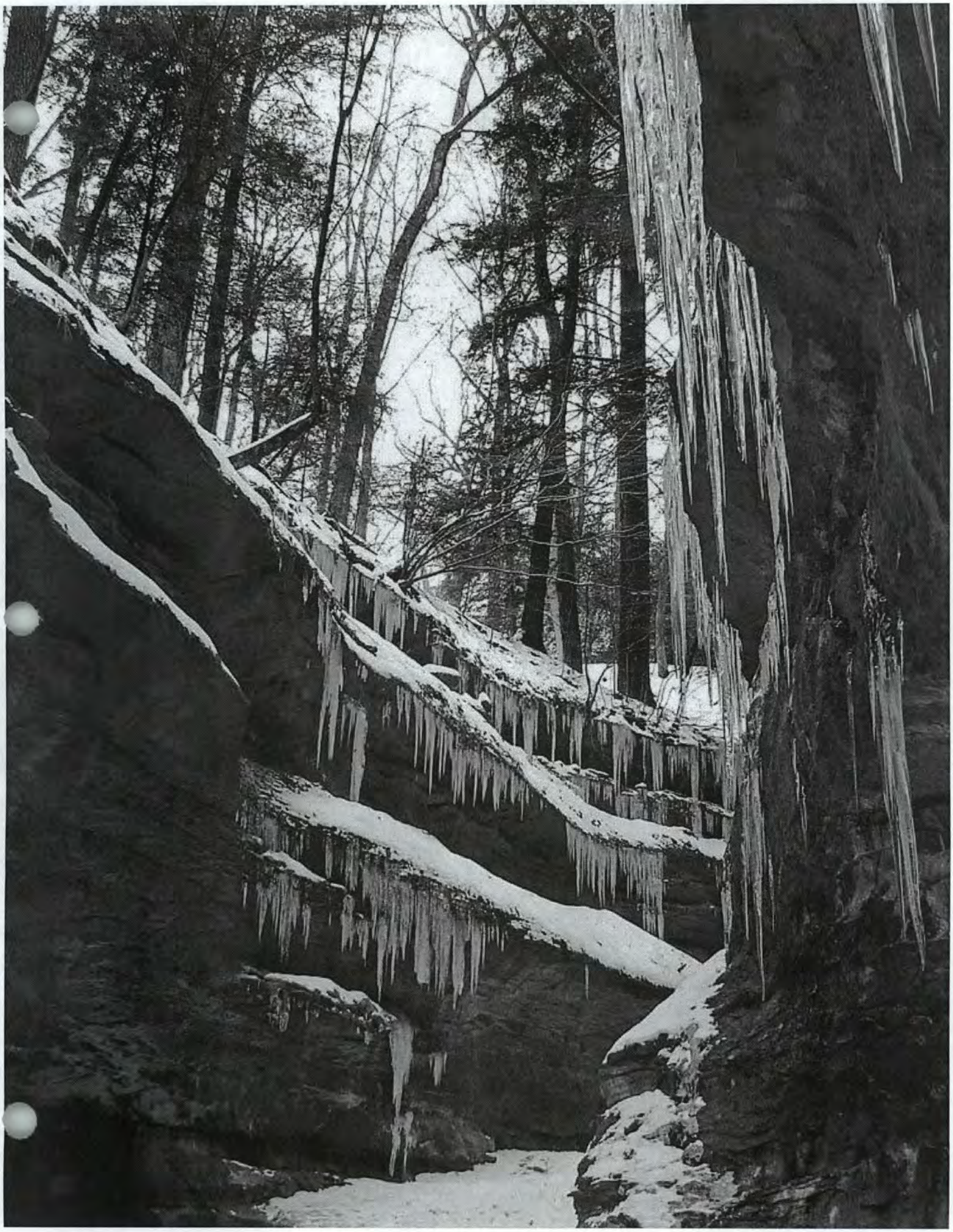
The above literature has all been carefully considered in the design and management of a new arboretum located in Muncie, Indiana. The review of past arboretums and their subsequent

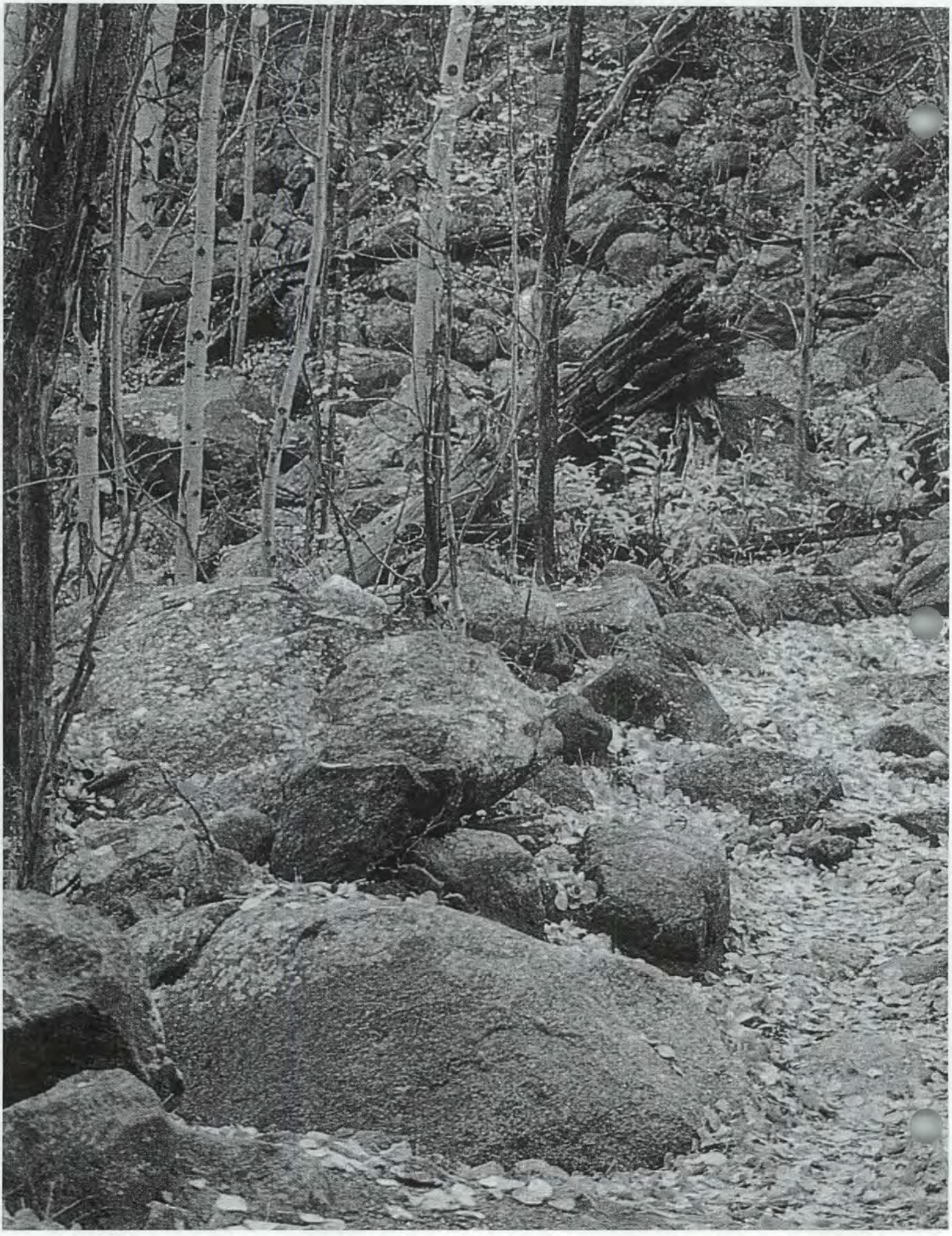
development has laid out planning guidelines and principles to be used in the new design. While attention has been paid to past principles of arboretum design, new guidelines, as postulated by Penn State, will also be helpful in the future planning and design consideration of a new arboretum.

While on the topic of arboretums, this study has also shown the vital role that they play in ecological restoration and management, especially in the face of climate change and the resulting loss of biodiversity. The process of restoring a degraded site involves the management of water, such as flood mitigation and run-off control, as well as creating a site that is easily managed so as to cut down on erosion and water waste. Trees have also been shown to be "keystone structures" in the landscape, providing key habitats in urban landscapes that are urgently need, especially for species such as birds and small mammals. In this way, the ecological role of trees is hard to be ignored and shows that the implementation of an arboretum on the current site of the Muncie Delaware County Fairgrounds would benefit no just the local ecosystem, but the surrounding community as well.

In discussing the implementation of trees on a previously degraded site, the research discussed above has proven that ecosystem services and biodiversity were higher in restored than in degraded systems and that managers should manage locally for regional diversity, showing that creating this small ecosystem will not only benefit the arboretum, but also the area at large. Research into the SITES Initiative has also shown that the direct and indirect influence of ecosystem services can be reached by a "step-by-step" framework plan that approaches existing elements in order to preserve, manage, restore, or generate high functioning ecosystems and increase landscape performance.

Finally, a critical analysis of the positive aspects of civic involvement and clear management practices in the individual sphere offered an insight as to how this arboretum may last far into the future. With these results, I will now be able to move forward with the arboretum design on the Delaware County Fairgrounds site.





PROBLEM STATEMENT

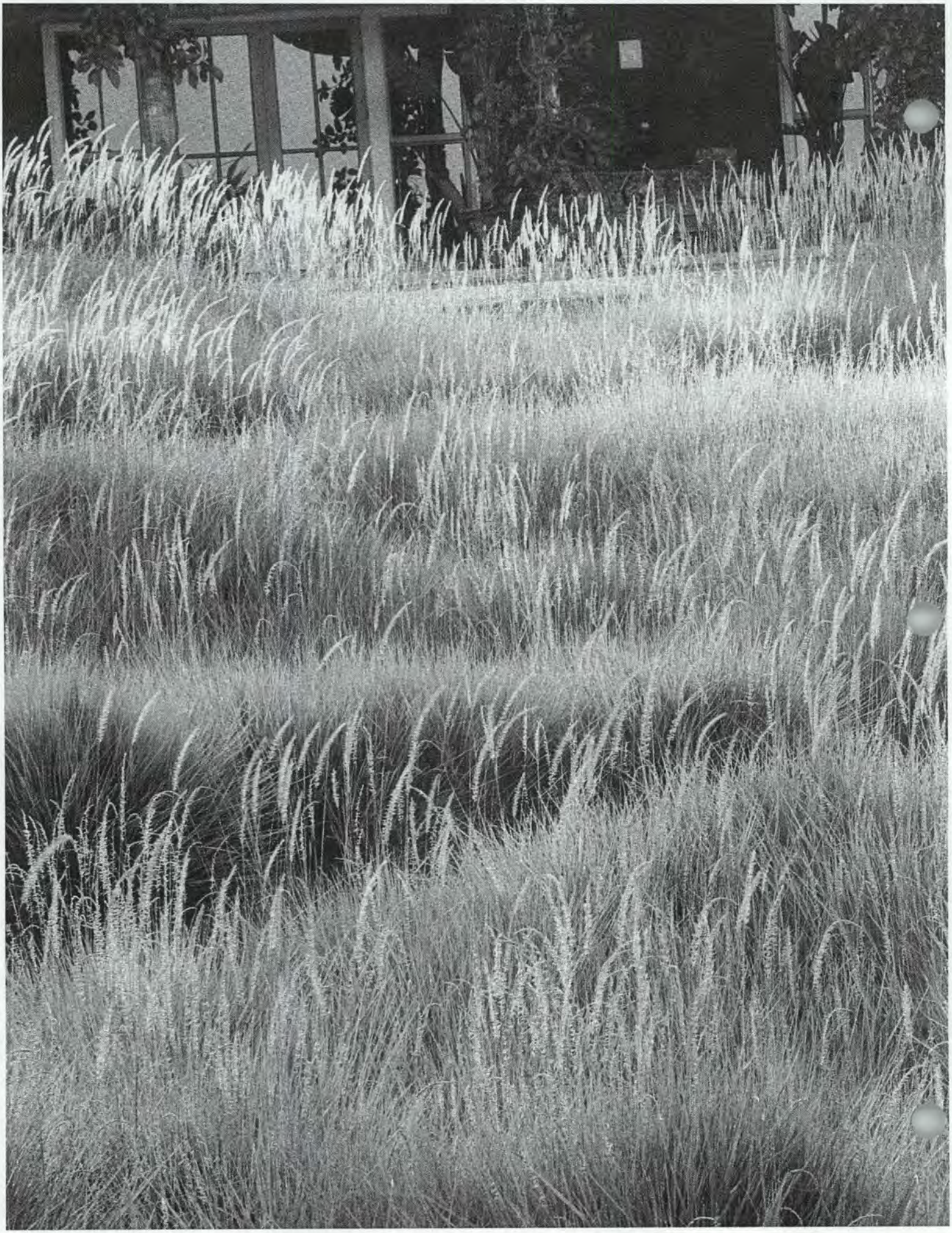
Who, What, When, Where, How, Why

PROJECT STATEMENT

The purpose of this study is to focus on the establishment and design of a tree-focused arboretum that supports local flora and fauna as well as the surrounding community by offering educational, recreational, and ecological opportunities. To fully understand the integration of these factors within the scope of an arboretum, it is first necessary to discover what makes an arboretum successful and how it should be established in relation to the natural heritage of the site. After these have been ascertained, the design will require a careful consideration of why a tree-focused arboretum has more benefits than a simple planted garden space and how it helps increase factors such as biodiversity and habitat. The concept of ecosystem services and site restoration will also be looked at, with a critical observation of how trees can increase biodiversity while also using the SITES guidelines to help ascertain measurable outcomes of a sustainable landscape. Finally, an extended look at management practices and civic involvement will be used to lead to better and more ecologically sound site maintenance for the future that will increase the longevity of the design.

PROJECT SIGNIFICANCE

Muncie is currently lacking a community-supported public park that focuses on environmental education related to the ecology of trees and how to engage with them in nature. Since the current site lacks sufficient ecosystem services, which leads to erosion, drainage issues, and negative impacts on tree health, I am exploring a tree-focused, natural heritage arboretum for Muncie, Indiana because it has the opportunity to enhance the ecology of the Delaware County Fairgrounds and provide more education about the history and ecosystems native to Muncie, Indiana. It has been shown that landscapes that include trees are less prone to flooding and erosion, are easier to manage than manicured landscapes, and provide critical habitat for a wide range of species. It will also help cultivate land stewardship among old and young alike by disseminating the knowledge of woody plants to foster understanding and appreciation of Earth's biology and its vital importance to humankind.



PROGRAM

What Will this Project Accomplish

PROJECT REQUIREMENTS

- Create ecologically sustainable and native ecology networks
    - Provide a comprehensive planting scheme of native and hardy tree and understory species
    - Pollinator specific perennial area
    - Seasonal interest areas
    - Visitor Center planting beds
    - Children's garden
    - Tree nursery

- Provide a cohesive pedestrian and traffic network
    - Primary walking paths on the outer edges, ADA accessible
    - Secondary walking paths through the site, non-ADA accessible
    - Northern and eastern parking lot with sustainable materials
    - Shuttle service
    - Pedestrian crossing through parking stalls

- Educational Opportunities
    - Educational signage
    - Way finding signs within a 2 mile radius of the site
    - Indoor/Outdoor classroom space (50-100 people maximum)
    - Adjacent two story visitor center that includes: horticulture exhibits, natural history, nature photography, a store, a café, equipment rental, and travelling exhibits
    - Children's garden
    - Special indoor atrium area for traveling exhibits

LEVEL ONE ARBORETUM GUIDELINES

According to the website Arbnet.org, there are four levels of accredidation an arboretum can acheive. The arboretum I designed achieves the first level of accredidation, under the following guidelines:

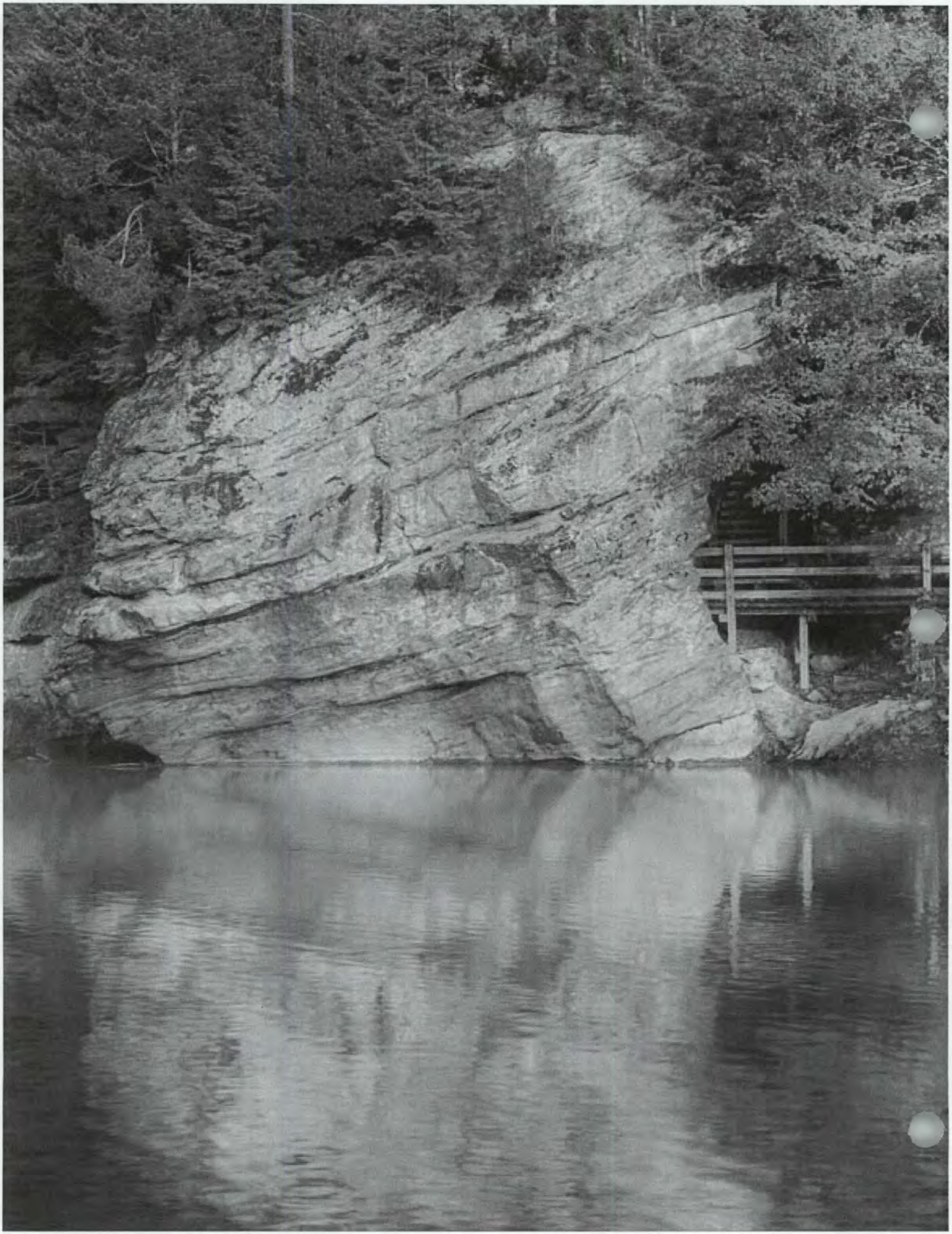
- An arboretum plan: documentation of some sort, such as an organizational plan, strategic plan, master plan, or other, that defines the purpose of the arboretum, its audience(s), the types of plants that are to be grown to achieve that purpose and serve those audiences, provisions for the maintenance and care of the plants, and provisions for the continuing operation of the organization through time with a clear succession plan*

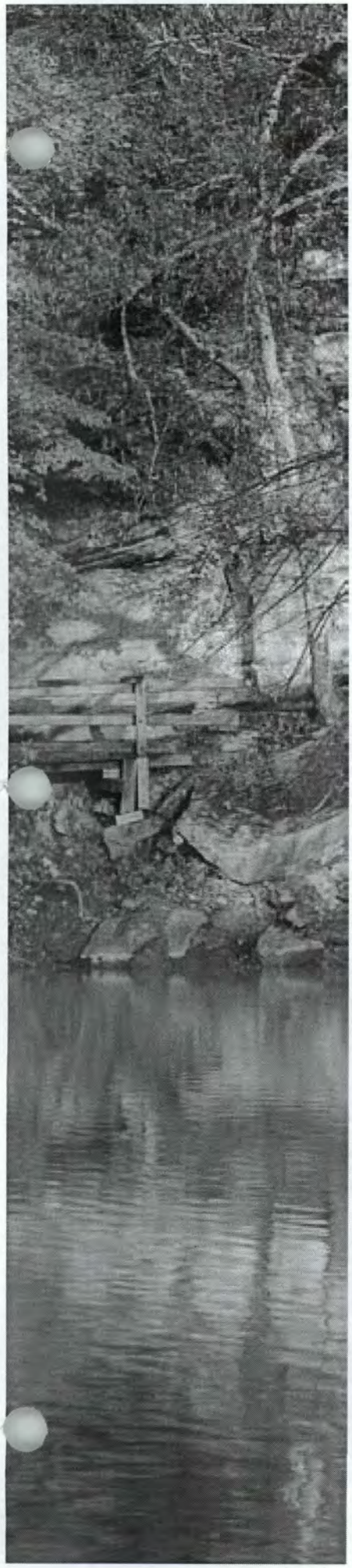
- An arboretum organizational group of people or governing board or authority that is dedicated to the arboretum plan and its continuation beyond the efforts of a single individual. Such an organizational group can affirm fulfillment of standards and authorize participation as an accredited arboretum.*

- An arboretum collection with a minimum number of 25 kinds (species or varieties) of trees or woody plants that have been planted and are growing in accordance with the arboretum plan. Plants in the arboretum collection must be labeled in some way as to identify them taxonomically, including scientific name and cultivar if applicable, and documented in some way so that information on their acquisition (source or origin, date of acquisition, etc.) is available for access.*

- Arboretum staff or volunteers who ensure fulfillment of the arboretum plan and provide for the basic needs of the arboretum collection and functions of the arboretum.
An arboretum public dimension that includes some level of public access, and at least one public event or educational program each year focused on trees or arboretum purposes (for example, an Arbor Day observance).*

*All guidelines are taken directly from the website





DESIGN PROCESS

Inventory, Analysis, Concepts, and Final Designs

INVENTORY AND ANALYSIS

SITE LOCATION

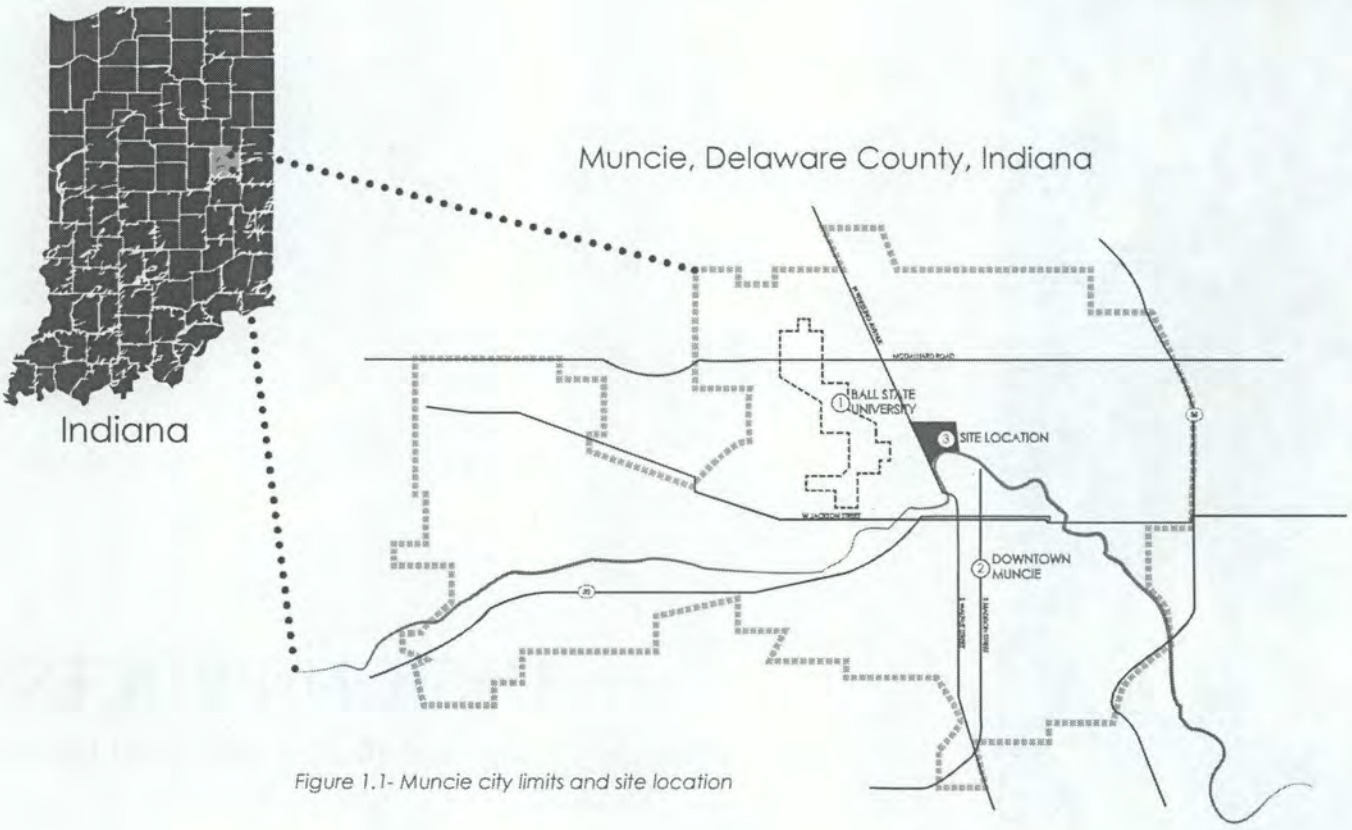


Figure 1.1- Muncie city limits and site location

NATIVE ECOLOGY-DECIDUOUS FORESTS AND WET MEADOWS

Figures 1.2-5-Native ecology types

Figure 1.6-Site and boudnary outlined

The current 42 acres of the Delaware County Fairgrounds is suffering from erosion, poor water management, and tree degradation (see Appendix (Fig. 1.75-8). The site is highlighted in pink, but also outlined is the area considered in addition to the fairgrounds, which includes Minnetrista and it's connections (Fig. 1.6).

Figure 1.7-Looking south towards Minnetrista Boulevard

The picture above (Fig. 1.7) was taken at the south end of the site, just past the current entrance off Wheeling Avenue. It most effectively captured the soil erosion issues, as well as the current lack of trees. The water from the road will runoff into the ditch to the left, and then will sit there, not draining into the loamy-clay soil, which kills off the grass. The hope with this new design is that large swaths of lawn will be eliminated and replaced by healthy forest biodiversity with a carpet of ferns, spring ephemerals, and cool season grasses.

SITE DATA

The map below is showing data that proves the site does not lie on a 100 year floodplain, which means that it is safe and ethical to build on (Fig 1.8). If there had been design decisions to create new construction on a floodplain, it would have been damaging the habitat for important native species, as well as providing an unsafe environment for both buildings and any visitors that may be on the site.

Figure 1.8- 100-year-floodplain

Figure 1.9- New site location

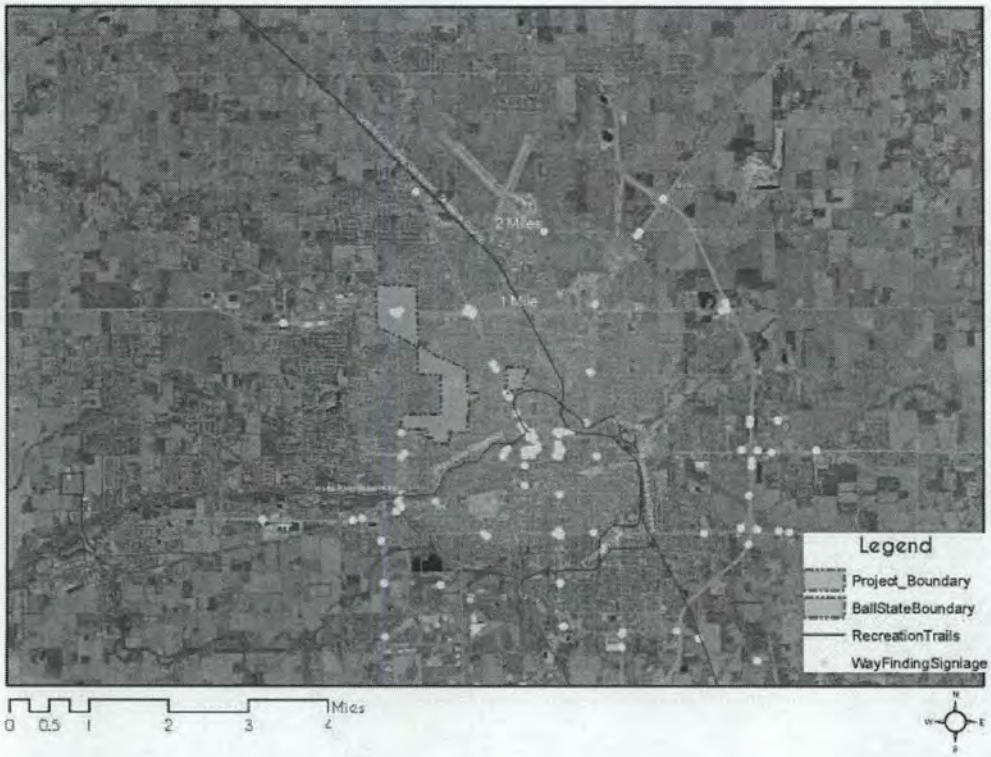
Because the Delaware County Fairgrounds are used year-round, a new location was proposed for the fairgrounds, which is easier to get to for large trucks and has more land available(roads are 70' instead of 50') (Fig. 1.9).

This map is important when considering what types of plants will thrive on the site and what plants might not make it after five years. The soils listed below are all considered urban land, which means that it has been compacted for so long that it is no longer easily identifiable (see Appendix Fig. 1.79). The soil mixtures listed below, however, have a lage amount of loam and clay in them, which means a pong and stream system on

Figure 1.10- Site soil classifications

the new site will not require large amounts of plastic liner to retain water, making it a much more natural pond system. The last point of data that can be gained from this map is that all the soils do not seem to contain large amounts of granite or rock down to 31 inches in the soil, which means that ammending it could be quite easy to accomplish. There are also minimal contaminants in it. For a full listing of soil types, please see the Appendix (Fig. 1.80-2).

Figure 1.11- Proximity to trails and signage

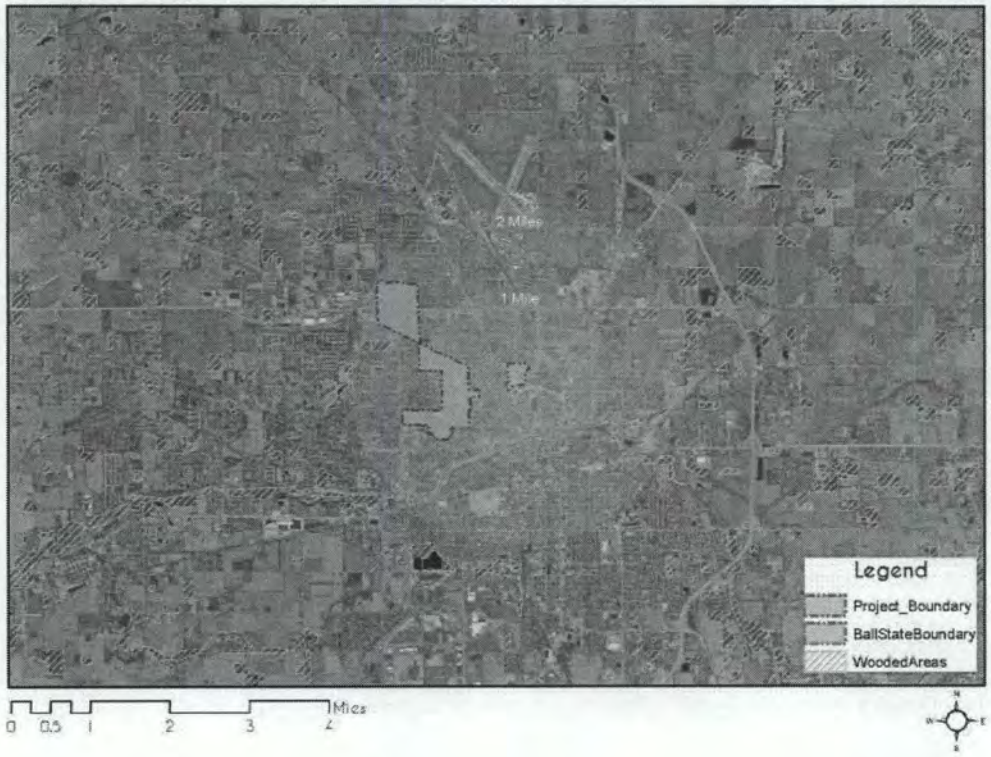


Pros:

-White River Greenway is directly south of the site, easy connection

-Existing signage in the 2 mile buffer zone means that I can add directional markers to those for the new arboretum instead of funding the addition of new signs

Figure 1.12- Proximity to wooded areas



Pros:

-There are not many wooded areas within the 2 mile radius of my site, but many outside, meaning that my site could become a destination for those who live closer to downtown and urban Muncie

Figure 1.13- Vacant parcels, buildings, and MITS network

Pros:

-MITS lines run both N/S and E/W, creating plenty of accessibility for those without cars
-Vacant parcels could be used to extend the entrance of the arboretum

Cons:

-Residential on western edge of site will need to be addressed through planting decisions

Because the current site is a highly used and trafficked area, special attention was paid to it's proximity to trails and signage (Fig. 1.11), existing wooded areas (Fig. 1.12), vacant parcels of land, and the MITS transportation network (Fig. 1.13). These diagrams enabled a cohesive design strategy that integrated existing amenities into the proposed ones.

CURRENT SITE PHOTOS

These photos were taken during November of 2015 (Fig. 1.14-9)

Figure 1.14-Places where water does not drain

Figure 1.15-Soil erosion along the existing pathways

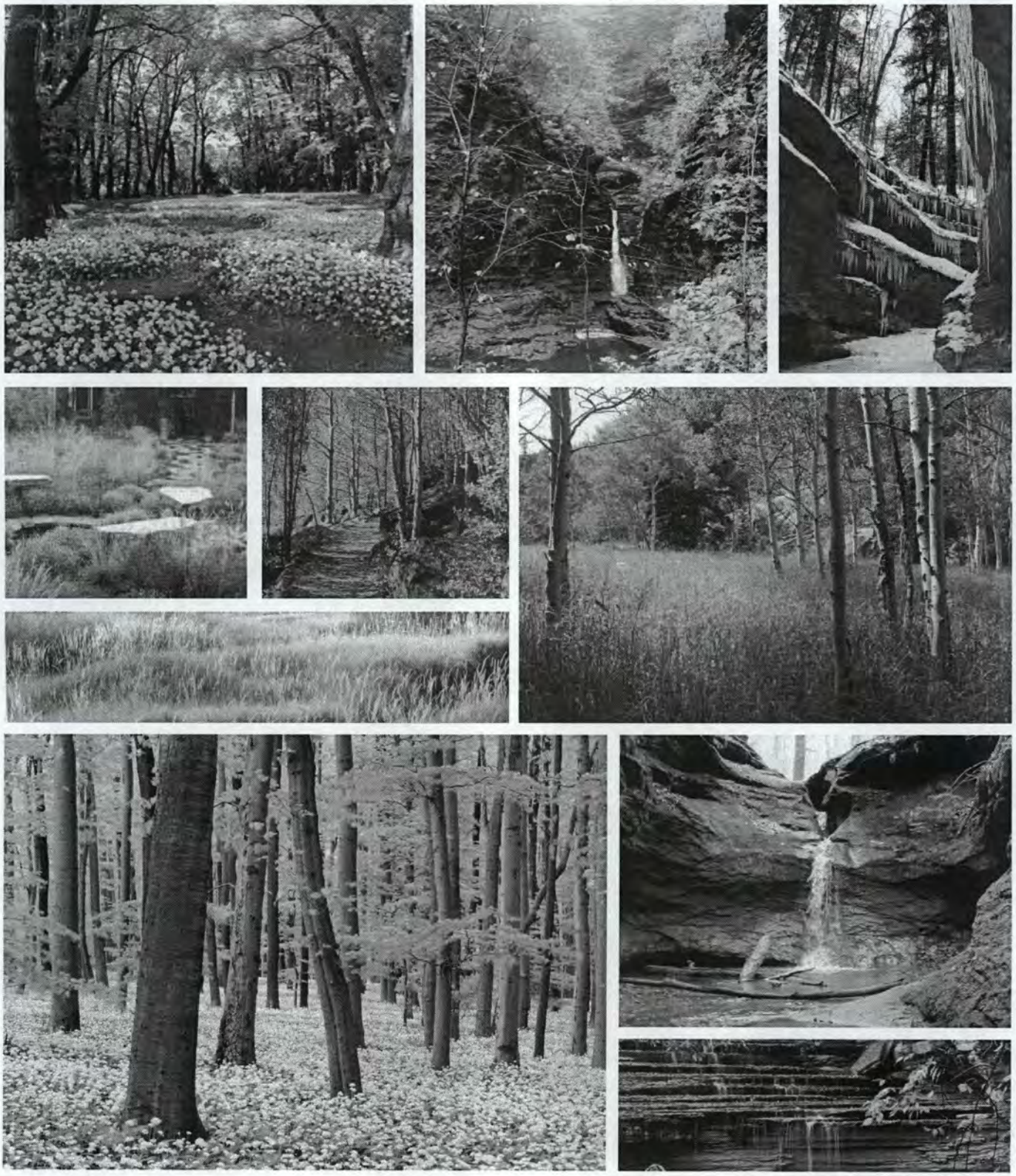
Figure 1.16-Main corridor through the fairgrounds

Figure 1.17- A panoramic view of the fairgrounds looking north towards the bandstand, indicating where the ground slopes and where water is likely to gather.

Figure 1.18- Eastern edge of the fairgrounds, facing the Minnetrista Natural Area

Figure 1.19- Looking out from the bandstand; soil erosion and water management issues

MOOD BOARD



Figures 1.20-29-These are a series of images that I collected during my research that conveyed to me a sense of what I wanted my site to feel like, in all seasons.

DESIGN CONCEPTS

CONCEPT 1

Figure 1.30- Focus on relationships

The first concept was generated by thinking about the surrounding areas and what already existed, such as Oakhurst Gardens and how those might connect with a new zone on the site. Considerations of the most logical place to site the new visitors center and what new entrances could be added that would improve a visitor's experience to the site were also included (Fig. 1.30).

CONCEPT 2

Figure 1.31- Entrances and parking

This second concept started looking at possible connections to the Minnetrista grounds and how those entrances would influence a new design. Design features with parking lot sizes, pathways, nodes, and water features were also explored. The most important aspect of this design that came out of this concept was the inclusion of a northern parking lot along Centennial (Fig. 1.31).

CONCEPT 3

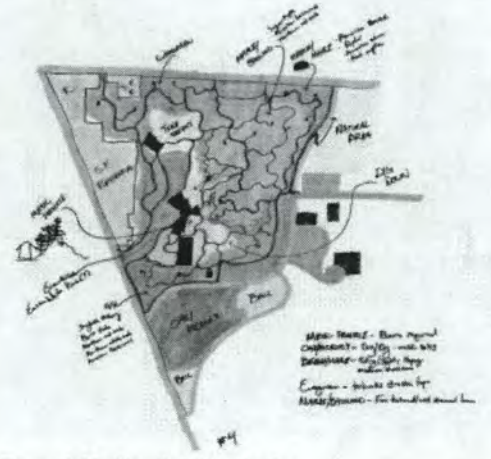


Figure 1.32- Planting typologies

Concept three started to define the residentail and retail zones around the site, so that new entrances and ecological zones might be properly placed. Planting palettes for the specific ecologies themselves were also implemented at this stage, which also figured out what conditions each would thrive under (Fig. 1.32).

Figure 1.33- Conceptual master plan

This is the final conceptual plan that was decided on to move forward with the design process. This plan includes a linear parking lot on the southern portion of the site, as well as one to the north. This decision was made to accommodate the amount of the people who might visit the site while also avoiding a large island of asphalt in the middle of the arboretum. The visitor's center has also been located on top of where all the old building pads for the site were, eliminating the need to create new foundation layers for the building. A large hill standing 15' above grade in the middle of the site was also added, which is shown by the sketched out contour lines (see original contour signature in the Appendix Fig. 1.74). Lastly, there is a tree nursery located to the northwest that will provide a space for new trees to be grown, as well as any research that needs to be conducted to keep the arboretum functioning at optimum capacity (Fig. 1.33). See the Appendix for vegetated protective zones during construction (Fig. 1.73)

SECTION VIGNETTES

These section vignettes (Fig. 1.34-36) were crucial to understanding of tree height and sightlines through various ecologies, as well as form and texture variety thatwere to be included in the design.

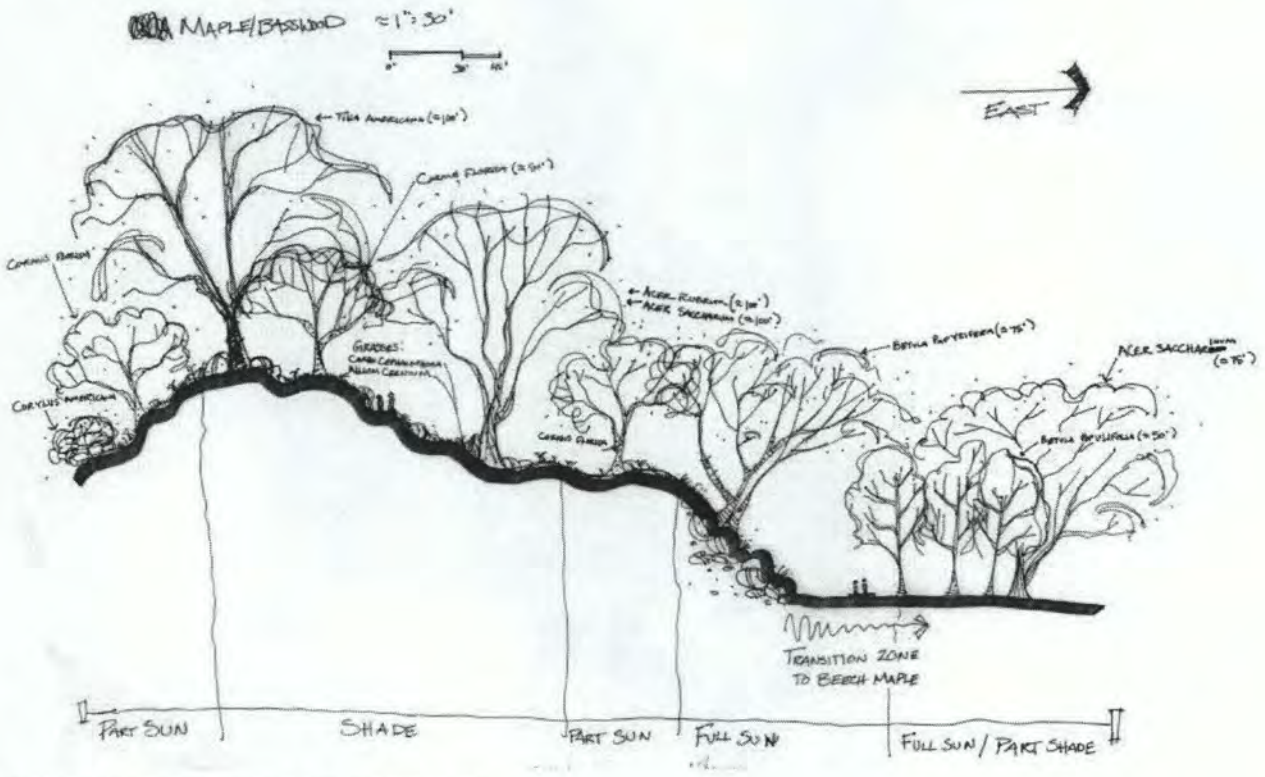


Figure 1.34-Maple/Basswood typology, change over grade

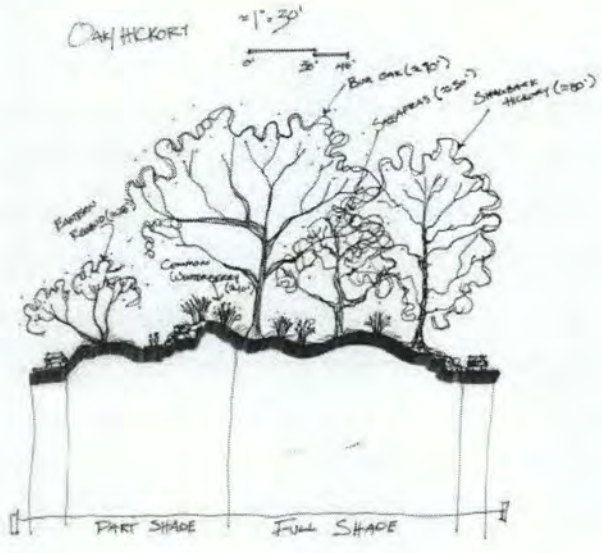


Figure 1.35- Oak/Hickory typology

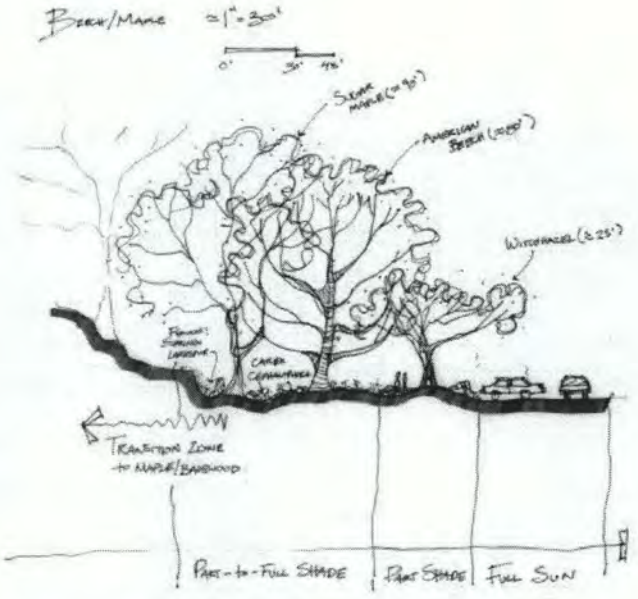


Figure 1.36- Beech/Maple typology, parking conditions

PERSPECTIVE VIGNETTES

Figure 1.37-40- Four vignette sketches of proposed ecologies

The four vignettes displayed above (Fig. 1.37-40) were quick sketch studies of key parts of the site that were going to be further developed in later renderings.

The first vignette is showing what a visitor might experience as they head into the Maple/Basswood forest coming from the pathway to the visitor's center.

The second vignette is showing the entrance from Centennial and how dense I would like the walk to be planted.

The third and fourth sketches are showcase edge conditions, such as the edge where the meadow meets the rock face or where the Beech/Maple forest meets the parking lot.

CONCEPT SKETCHES

Figure 1.41- Preliminary concept sketch of visitor's center and planting material

Figure 1.42- Section sketch through the children's garden

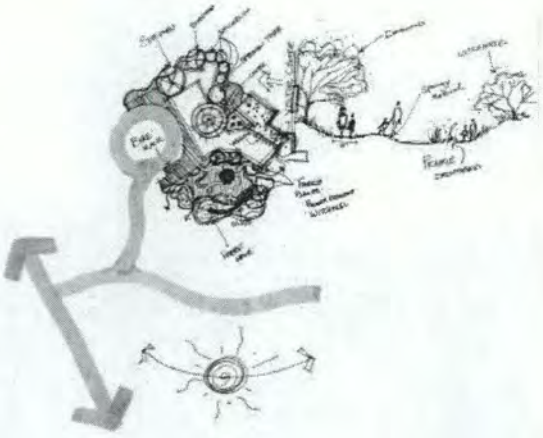


Figure 1.43- More refined sketches of the visitor's center and children's garden

These concept sketches were created to generate ideas for the visitor's center and children's garden. These are the final concepts that were used, including a consideration of how circulation would be maintained to the visitor center drop off and pathways through the children's garden (Fig. 1.41).

Planting palettes were also explored at this stage to discover which materials would best suit the buildling style and the whimsical feel of the children's garden (Fig. 1.42 and 1.43). Specific grade changes were observed that would make the most sense at a human scale in the children's garden, rather than the grandiose scale of the hill in the middle.

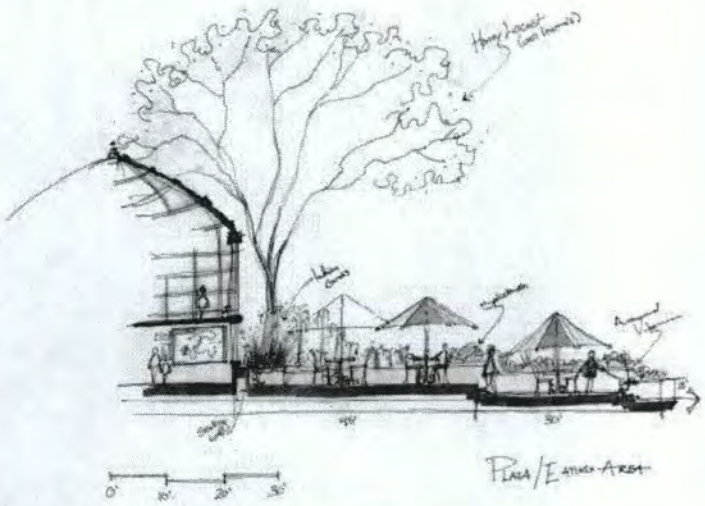


Figure 1.44- Section sketch of an outdoor patio and eating area that steps down into the meadow

SECTION 1

This first section (Fig. 1.44) cuts through the two-story glass atrium and out onto the eating veranda, where different levels of seating as well as a plant palette behind the seating wall were explored. This was especially helpful in determining exactly how high the plants needed to be in order to clear the top of the seating wall.

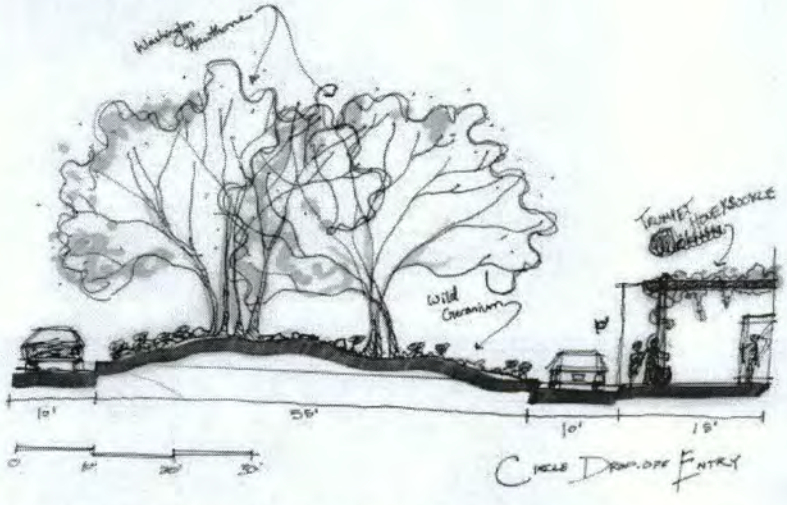
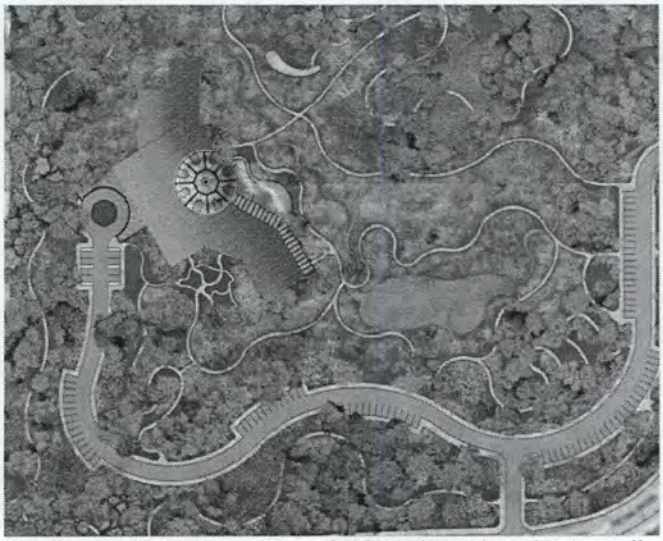


Figure 1.45- Section sketch of the drop-off at the visitor center entrance

SECTION 2

This section (Fig. 1.45) was exploring the relationship between the circular drop off and the entrance to the visitor's center, which needed to be decorative as well as functional. The decisions to go with low growing geraniums here as a groundcover enabled a constant line of site around the drop-off. A decorative vine to adorn the entrance pagoda was also chosen.

Figure 1.46- Master plan showing four distinct ecologies, parking, and building footprints



{50} *Figure 1.47- Visitor center and children's garden with drop-off*

Figure 1.48- Tree nursery and proposed access road

KEY FEATURES

1. Tree Nursery and Research Facility
2. Trailhead
3. Visitor Center and Children's Garden
4. Outlook
5. Maple/Basswood Forest
6. Beech/Maple Forest
7. Meadow
8. Oak/Hickory Forest

The final concept for the arboretum is one that integrates existing connections with Minnetrista and reforms the landscape to create a visually appealing design that varies in both topography and plant material. Working with four distinct and native Indiana ecologies, plant material was blended together to create a cohesive design that mimicks what might have occured on the site 200 years ago, while also being sensitive to what these current ecologies might need to survive in the future. The design also includes:

- Visitor's Center (approx. 100,000 sq. ft.)
- Children's Garden (approx. 11,500 sq. ft.)
- 124 compact parking spots
- 8 handicap parking stalls
- Drop-off circle 80' in diameter
- Walking paths that are 10' wide

Figure 1.49- New north area parking and trailhead

Figure 1.50- Proposed connections to Minnetrista

SECTION A-A1

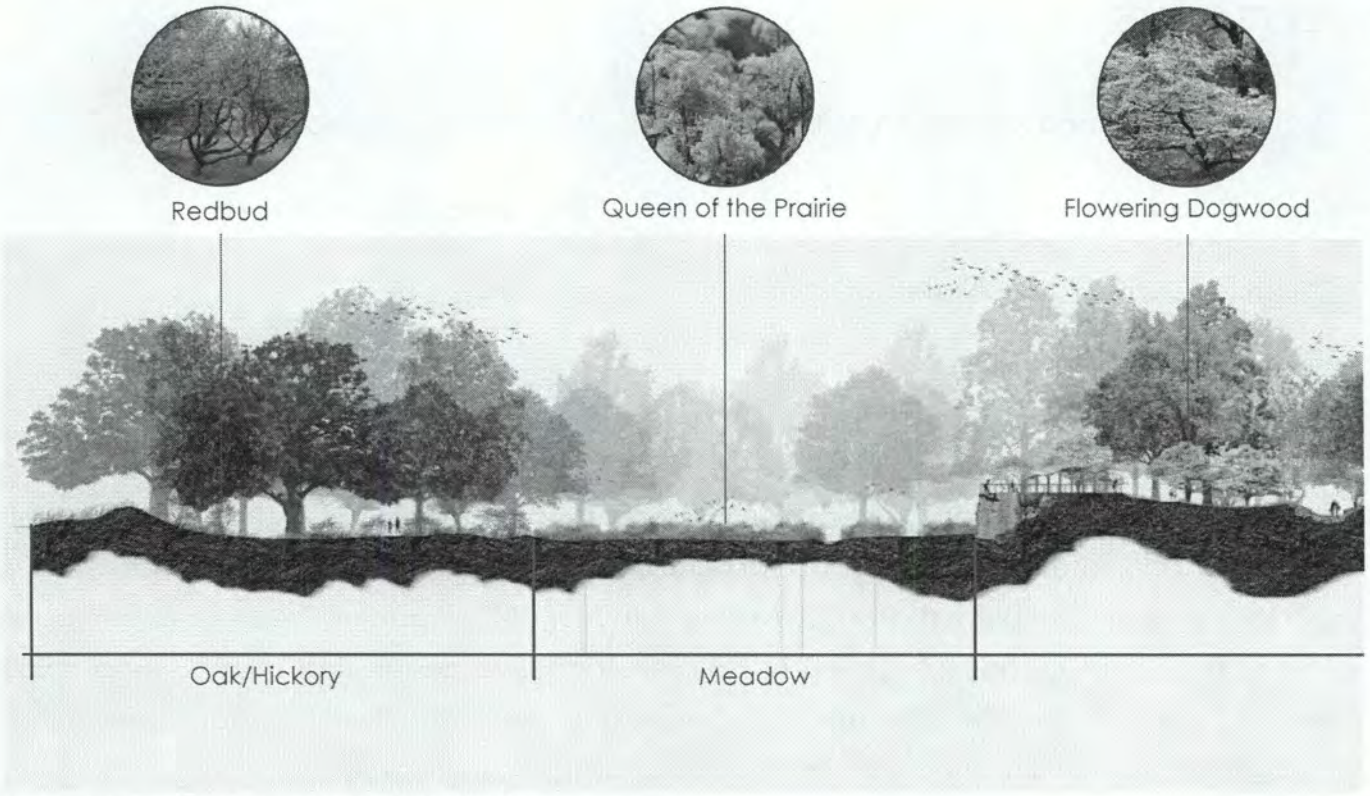


Figure 1.51- A longitude cut through the site during spring

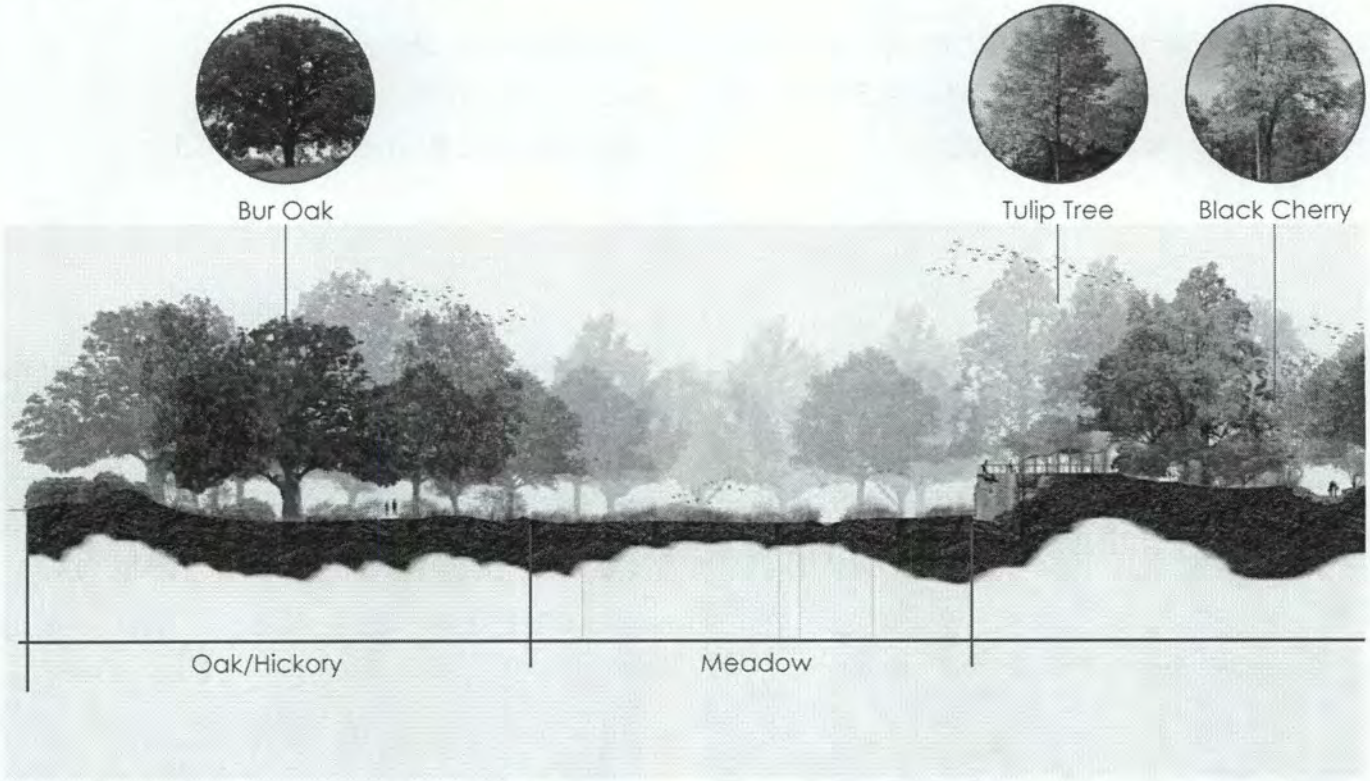
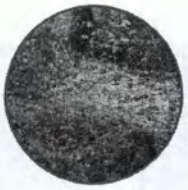
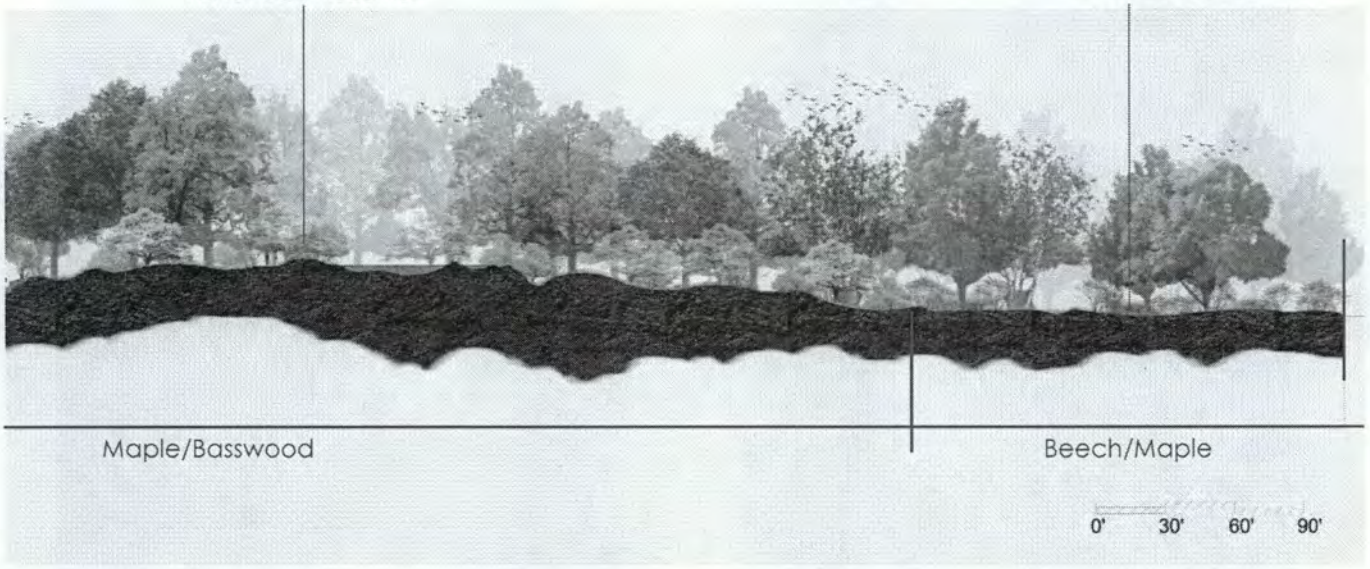


Figure 1.52- A longitude cut through the site in early fall

American Hazelnut

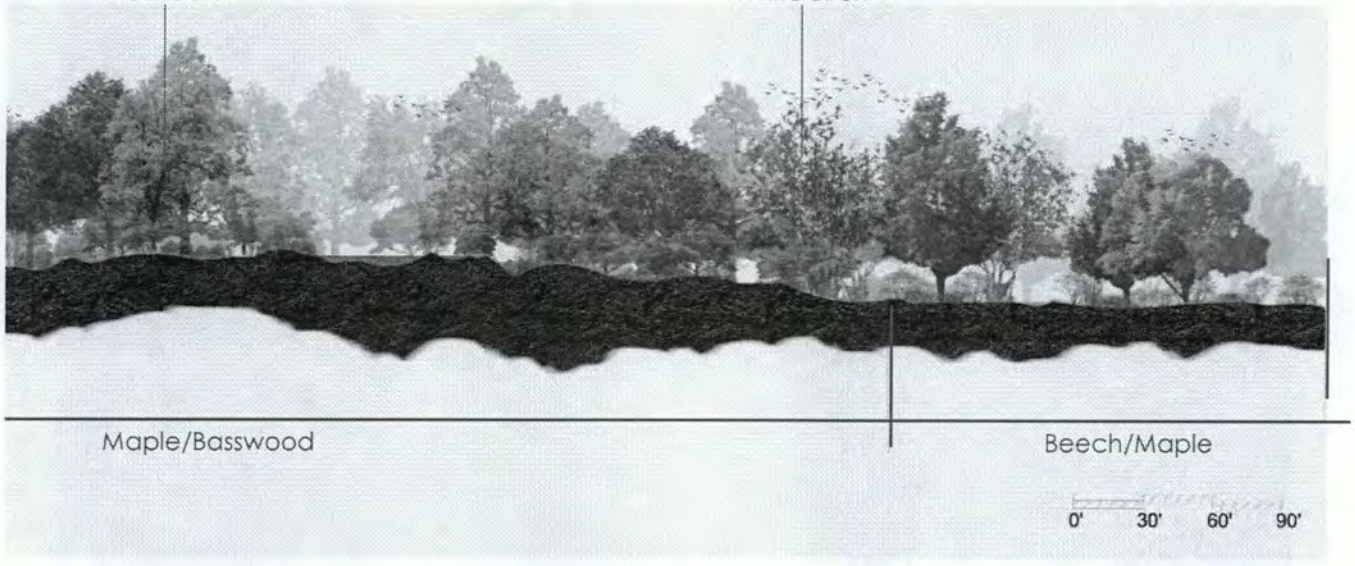


Blue Phlox



Red Oak

White Birch



TYPOLOGIES

MAPLE/BASSWOOD

OVERSTORY

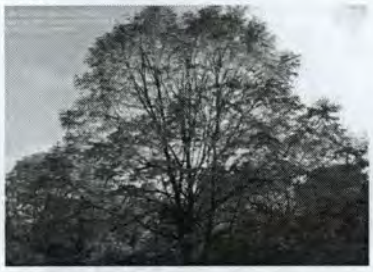
UNDERSTORY

GROUNDPLANE

Figure 1.53- Typology rendering of a Maple/Basswood forest in early fall

This typology (Fig. 1.53) is the centerpiece of the whole arboretum, rising up 15 to 20 feet above the site and dominating the view with a densely forested canopy. Many species are included that produce a vibrant fall color, as well as many ornamental understory trees that bloom spectacularly in the springtime. The edges of this zone are also characterized by stone outcroppings, which Paper Birches are known to grow well on and which provide a nice contrast to the soft vegetation of the forest. The planting plan is located in the Appendix (Fig. 1.64).

Red Maple
Acer rubra



American Basswood
Tilia americana

Tulip Tree
Liriodendron tulipifera

Red Oak
Quercus rubra

Flowering Dogwood
Cornus florida

Paper Birch
Betula papyrifera

Serviceberry
Amalanchier arboreta

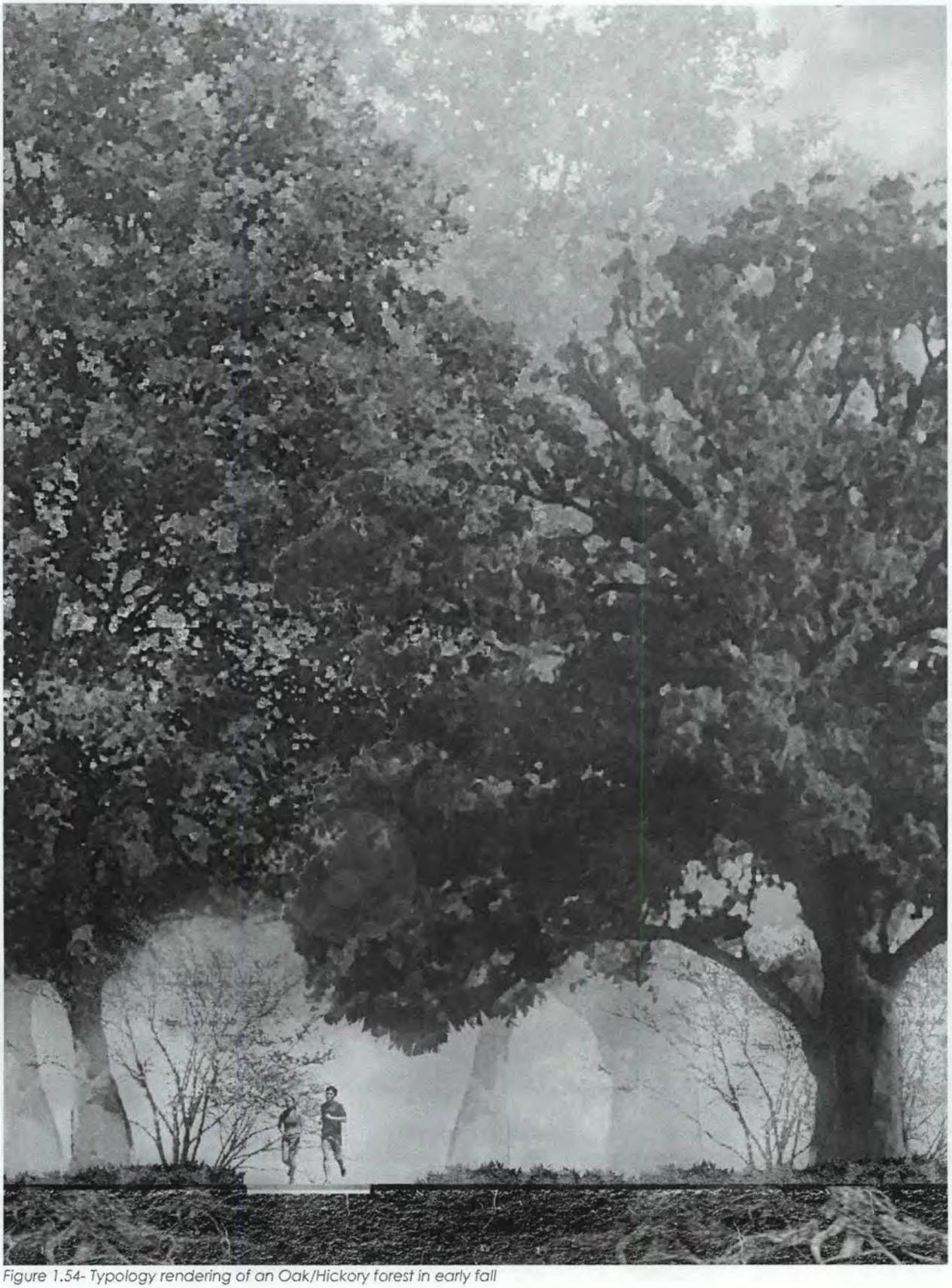
Sweetbay Magnolia
Magnolia virginiana

Maidenhair Fern
Adiantum pedatum

Oval Leaf Sedge
Carex cepholaphora

Nodding Wild Onion
Allium cernuum

OAK/HICKORY



OVERSTORY

UNDERSTORY

GROUNDPLANE

 Figure 1.54- Typology rendering of an Oak/Hickory forest in early fall

The Oak/Hickory typology (Fig. 1.54) already exists in Oakhurst Gardens at Minnetrista, so this planting scheme was not hard to extend from that. It also provides dense coverage, which is why it was placed near existing residences and retail so as to create a boundary between the two that was not a physical fence. This is the most common typology in and around the Delaware community. The planting plan is located in the Appendix (Fig. 1.66).

Bur Oak
Quercus macrocarpa

Shagbark Hickory
Carya ovata

Scarlet Oak
Quercus coccinea

American Witchhazel
Hamamelis virginiana

Gray Dogwood
Cornus racemosa

Eastern Redbud
Cercis canadensis

Winterberry
Ilex verticilata

Maidenhair Fern
Adiantum pedatum

Oval Leaf Sedge
Carex cepholaphora

Nodding Wild Onion
Allium cernuum

BEECH/MAPLE

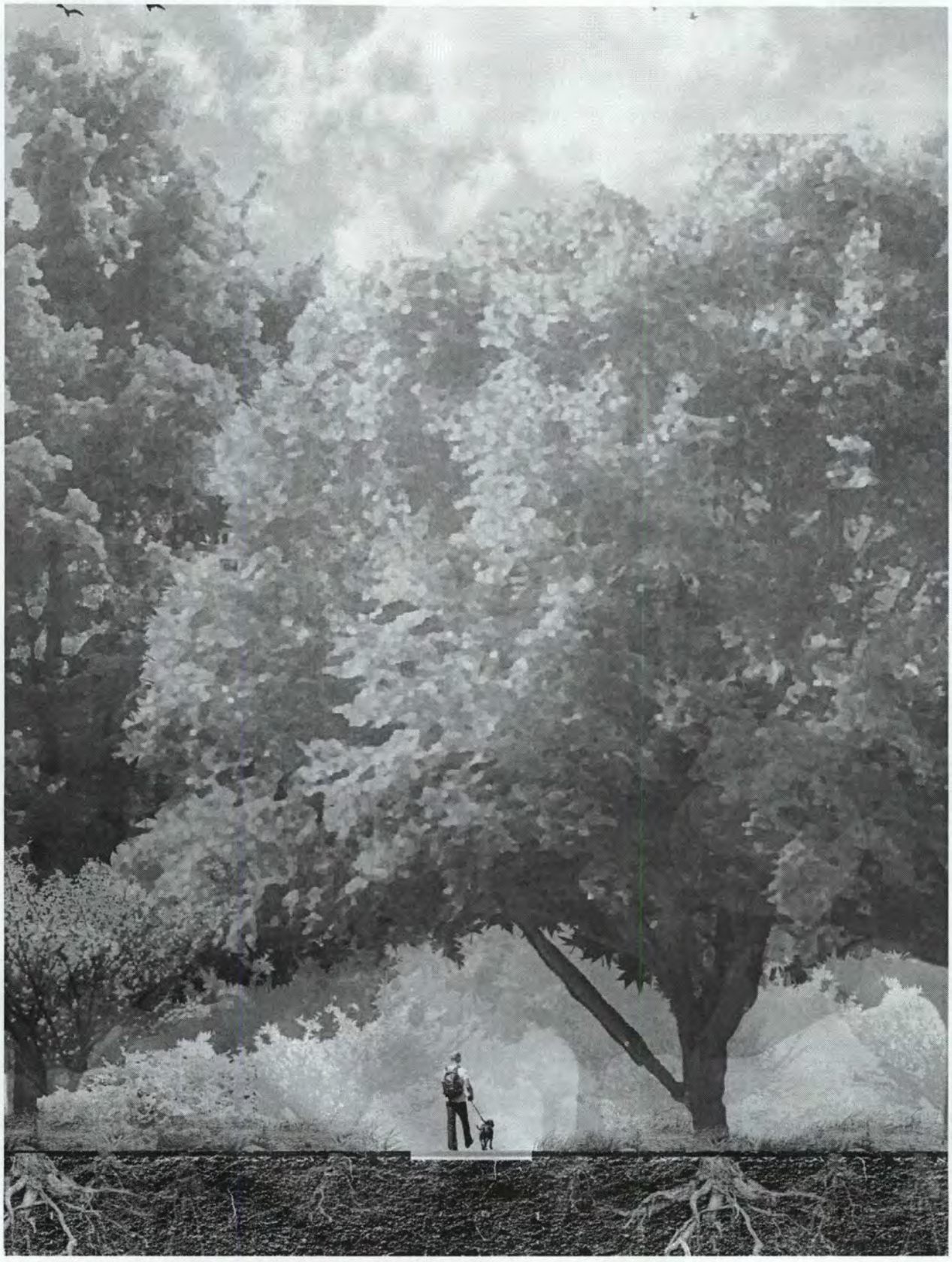


 Figure 1.55- Typology rendering of a Beech/Maple forest in early fall

The Beech/Maple typology (Fig. 1.55) is an important lowland forest area that provides dappled shade and cover for small mammals and birds. It was placed near parking and the exterior of the site so that it does not loom up like the more heavily forested Maple/Basswood or Oak/Hickory typology. The planting plan is located in the Appendix (Fig. 1.62).

Bur Oak
Quercus macrocarpa

American Beech
Fagus grandifolia

Silver Maple
Acer saccharinum

Sugar Maple
Acer saccharum

American Witchhazel
Hamamelis virginiana

Spicebush
Lindera benzoin

Grey Birch
Betula populifolia

Maidenhair Fern
Adiantum pedatum

Bottlebrush Grass
Elymus hystrix

Wild Blue Phlox
Phlox divaricata

{60} *Figure 1.56- Typology rendering of a dry and meisc meadow in springtime*

The mesic prairie and meadow area (Fig. 1.56) of the site will be split up into three distinct planting areas: wet, mesic (somewhat wet), and edge plantings. This will give the area a more diverse look, as well as providing habitat and nourishment for as many native mammals, birds, and insects as possible. The planting plan is located in the Appendix (Fig. 1.68).

White False Indigo
Baptisia alba

Prairie Dropseed
Sporobolus heterolepis

Sideoats Grama
Bouteloua curtipendula

Queen of the Prairie
Filipendula rubra

Cardinal Flower
Lobelia cardinalis

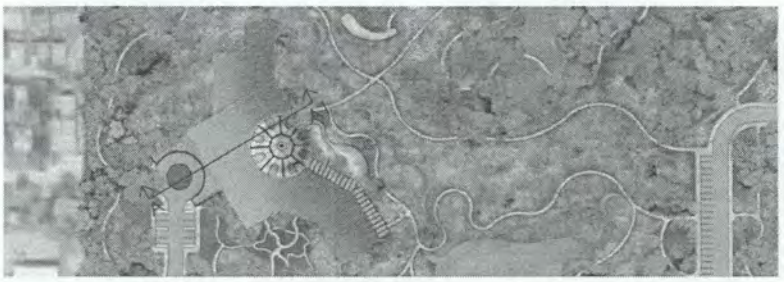
Thousand-Flower Aster
Boltonia asteroides

Sweet Coneflower
Rudbekia subtomentosa

Great Blue Lobelia
Lobelia siphilitica

Swamp Milkweed
Asclepias incarnata

VISITOR'S CENTER



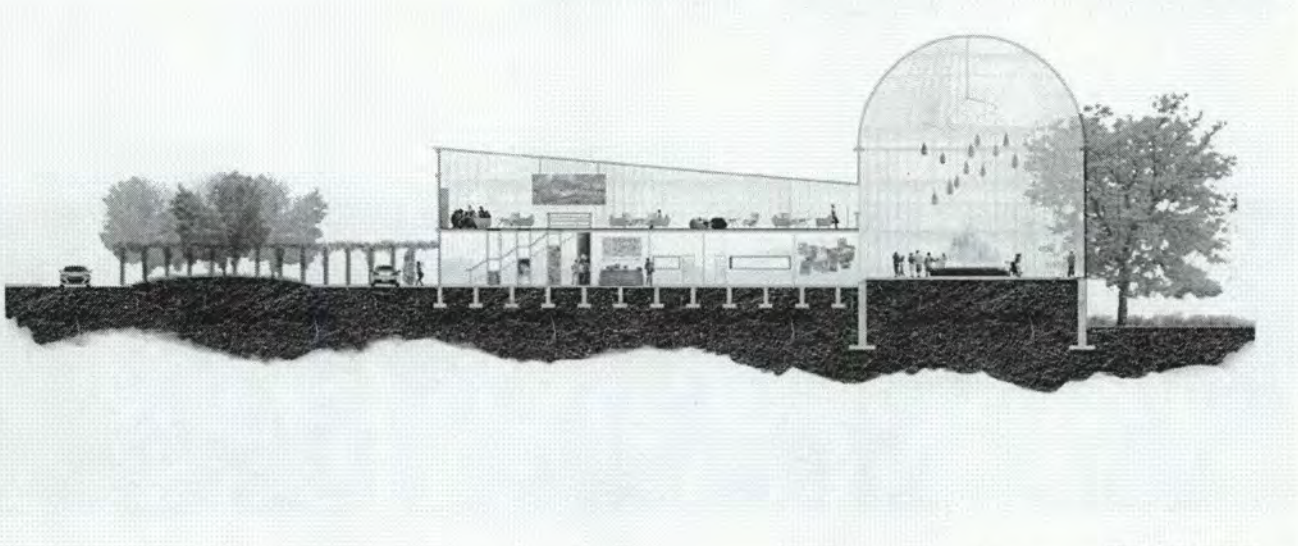


Figure 1.57- Section A-A1 cut through the proposed visitor's center

0' 30' 60'

The visitor's center (Fig.1.57) is located so that it looks out onto the mesic prairie and up into the rock formations of the Maple/ Basswood forested area. The materials used are metal, stone, and wood, to give the center a polished but natural feel. The interior hosts a cafe, full kitchen, two-story atrium space, a bookstore, a welcome desk, and classrooms. The exterior also features an outdoor eating veranda. The planting plan is located in the Appendix (Fig. 1.70).

Trumpet Honeysuckle
Lonicera sempervirens

Wild Geranium
Geranium maculatum

Washington Hawthorn
Crataegus phaenopyrum

Cucumber Magnolia
Magnolia acuminata

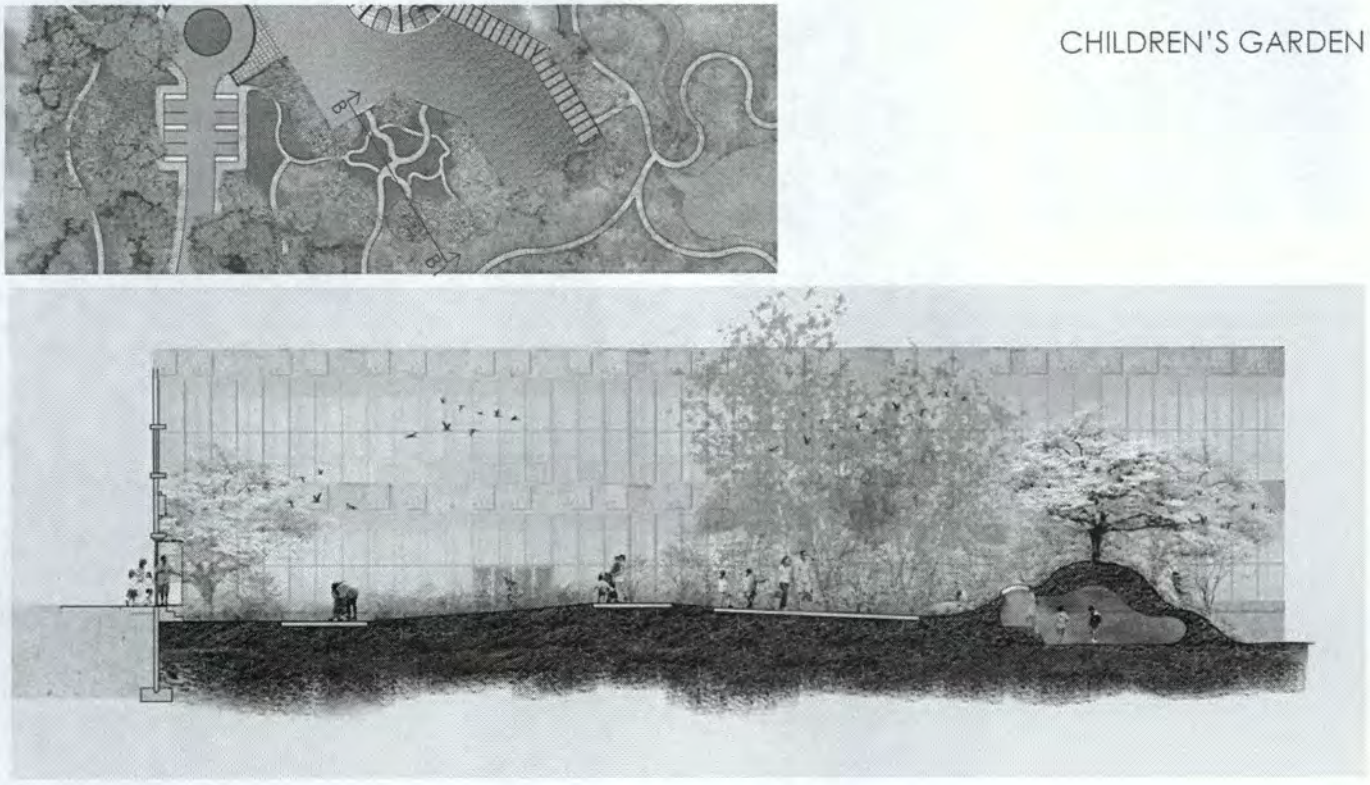


Figure 1.58- Section B-B1 cut through the proposed children's garden

The children's garden (Fig. 1.58) is located adjacent to the visitor's center and features a nature play mound instead of traditional play structure material. There are areas for children to run around and enjoy the tactile experience of playing with the plants, but there is also mounded earth and two gates to ensure that the parents can keep an eye on their children while letting them roam free. The planting plan is located in the Appendix (Fig. 1.70).

Indian Grass
Sorghastrum nutans

Pagoda Dogwood
Cornus alternifolia

Honey Locust
Gleditsia triacanthos v. inermis

Witchhazel
Hameamelis virginiana

Figure 1.59- The view as visitors ascend into the Maple/Basswood forest from the visitor's center

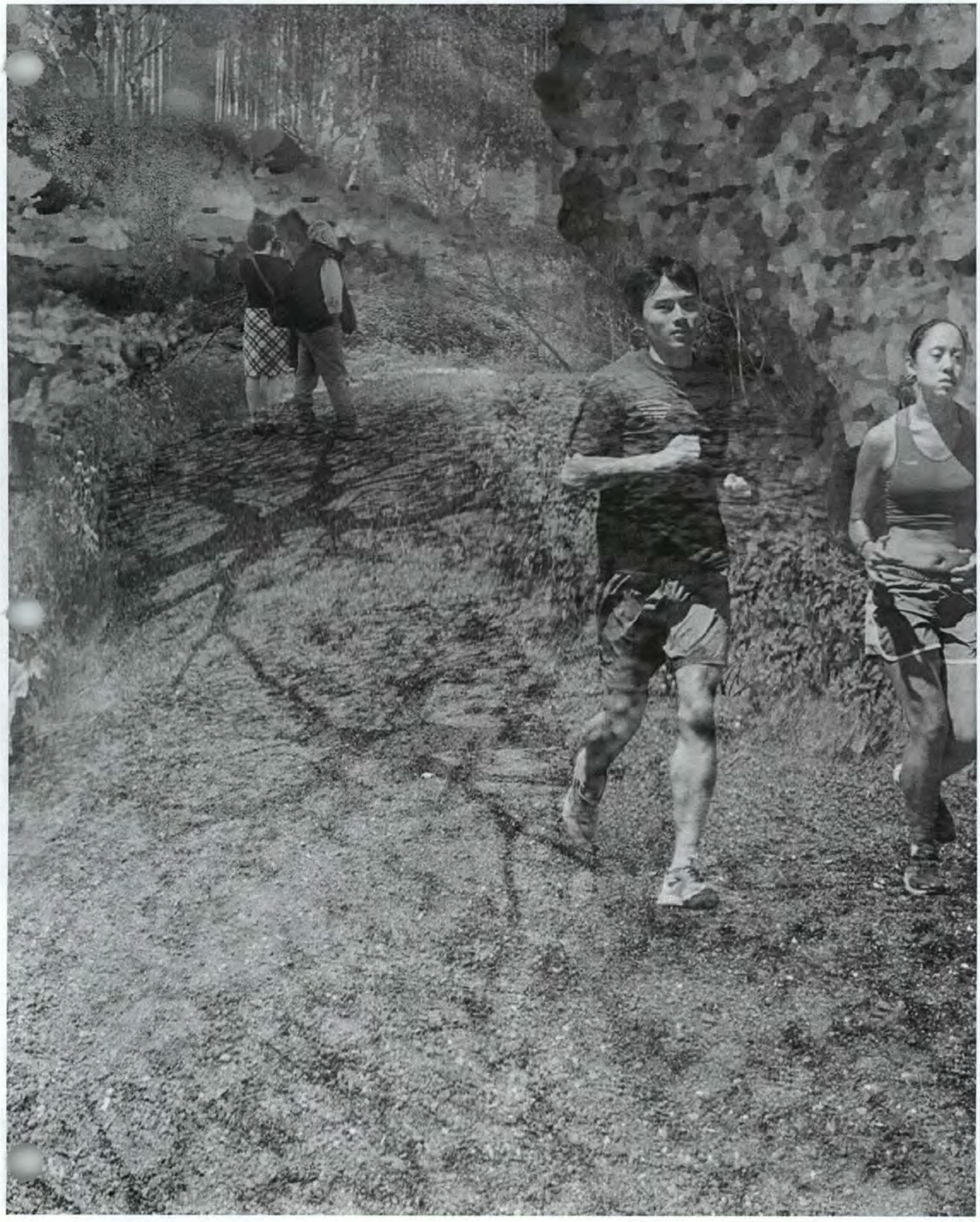


Figure 1.60- One of the two ponds located in the Maple/ Basswood forest

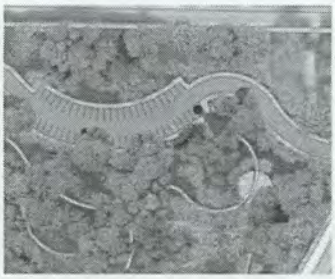
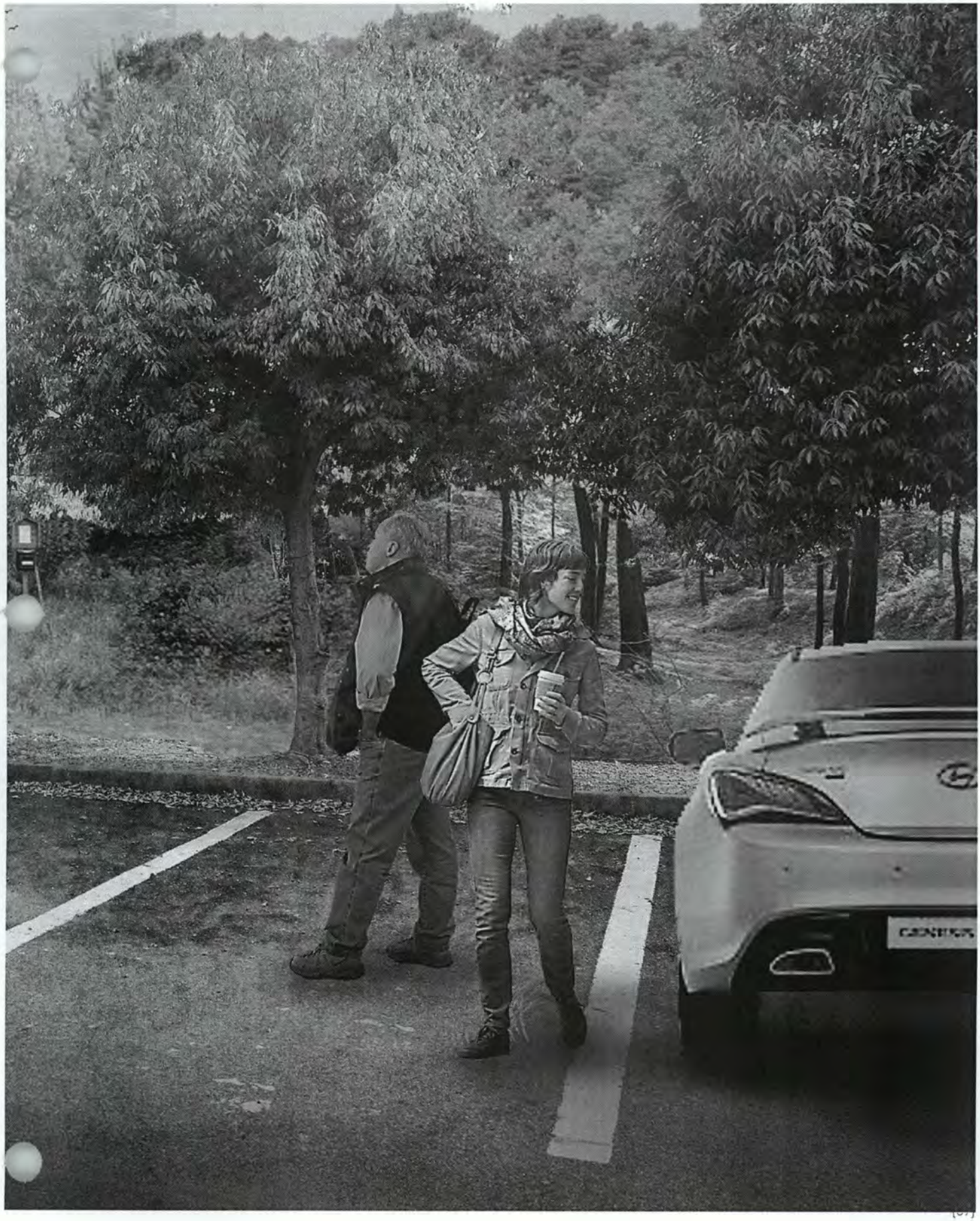


Figure 1.61- Looking towards the trailhead at the north end of the site



CONCLUSION

The Delaware County Arboretum is a project that aimed to combine ecological principles of design, such as water retention, erosion control, and invasive plant management, with education so that there might be an increased awareness of conservation strategies, land management, and environmental balance.

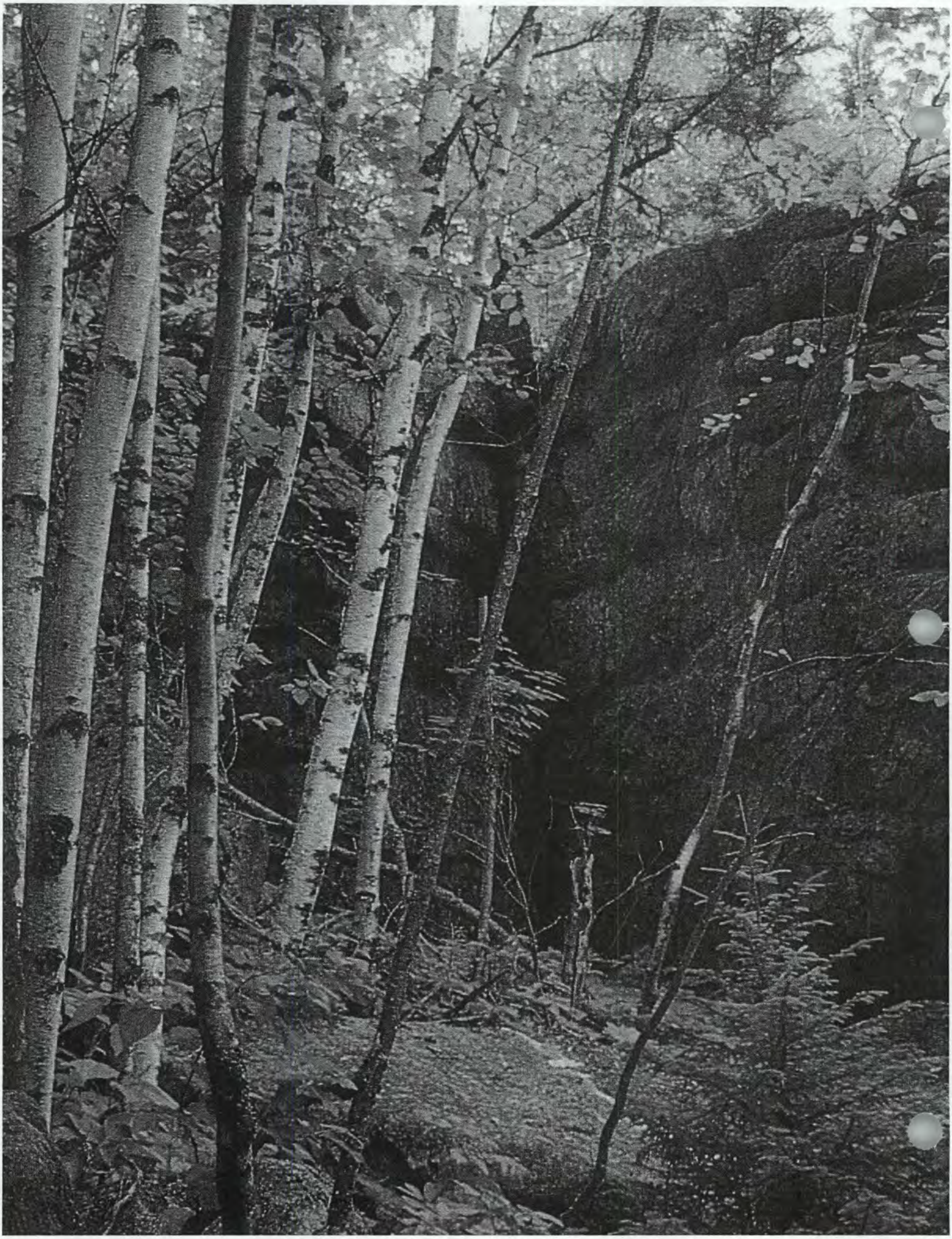
The fairgrounds have been located at this site for roughly 150 years, which has rendered the soil unsuitable for trees, and has led to an increasing tree mortality rate throughout the years. It has also greatly decreased the biodiversity and wildlife value of the site, which then reflects poorly on surrounding ecosystems.

This proposal looked at the historic nature of the site, looking back at the natural history of the area before human settlement, so that the new site might appropriately respond to the climactic and cultural conditions represented. There was also an equal amount of consideration for the site as it stands today and how the current settings might be changed to better enhance the ecosystem services offered, as well as increase the new design's resiliency for the future.

The preceding report covered the benefits of a tree-focused arboretum, a discussion of trees in relation to their ecosystem services and site restoration capabilities, and a look at how civic involvement

and management practices can make for a long-lasting site design. Also included were the methodologies and conceptual designs employed to work towards the outlined goals and the proposed planting plans, as well as an appendices that includes maps, images, GIS aerial views, and charts to support the listed research. The preceding designs were created with special attention to native Indiana ecologies and have the ability to be implemented in the real world, which is what makes this project stand out.

Overall, the new arboretum will last for a long time and minimal changes in management will be needed for at least 100 years, denoting it as a future space for learning, ecology, and historic restoration for Muncie and the Delaware County community at large.

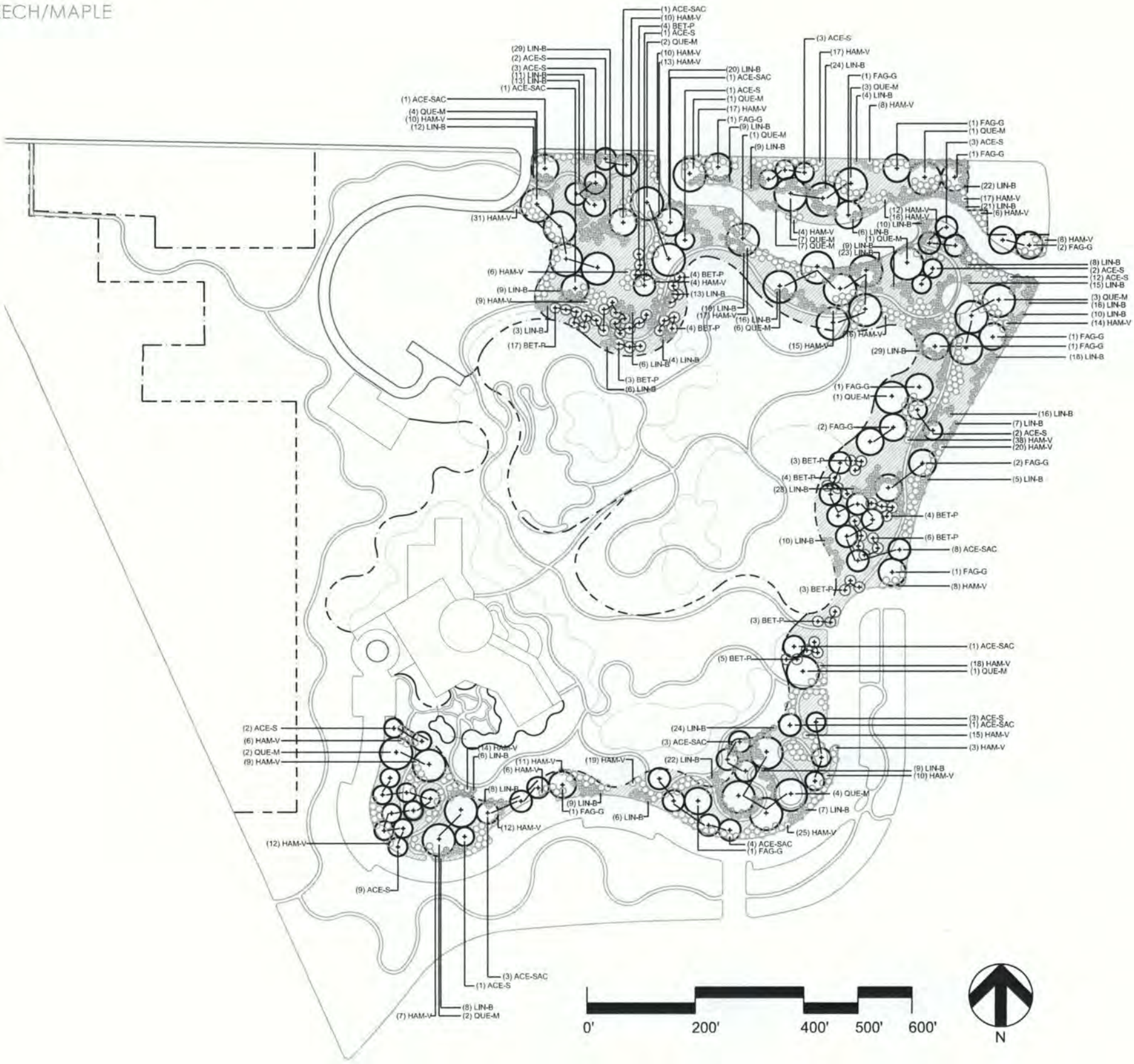


APPENDIX

Construction Documents and References

PLANTING PLANS

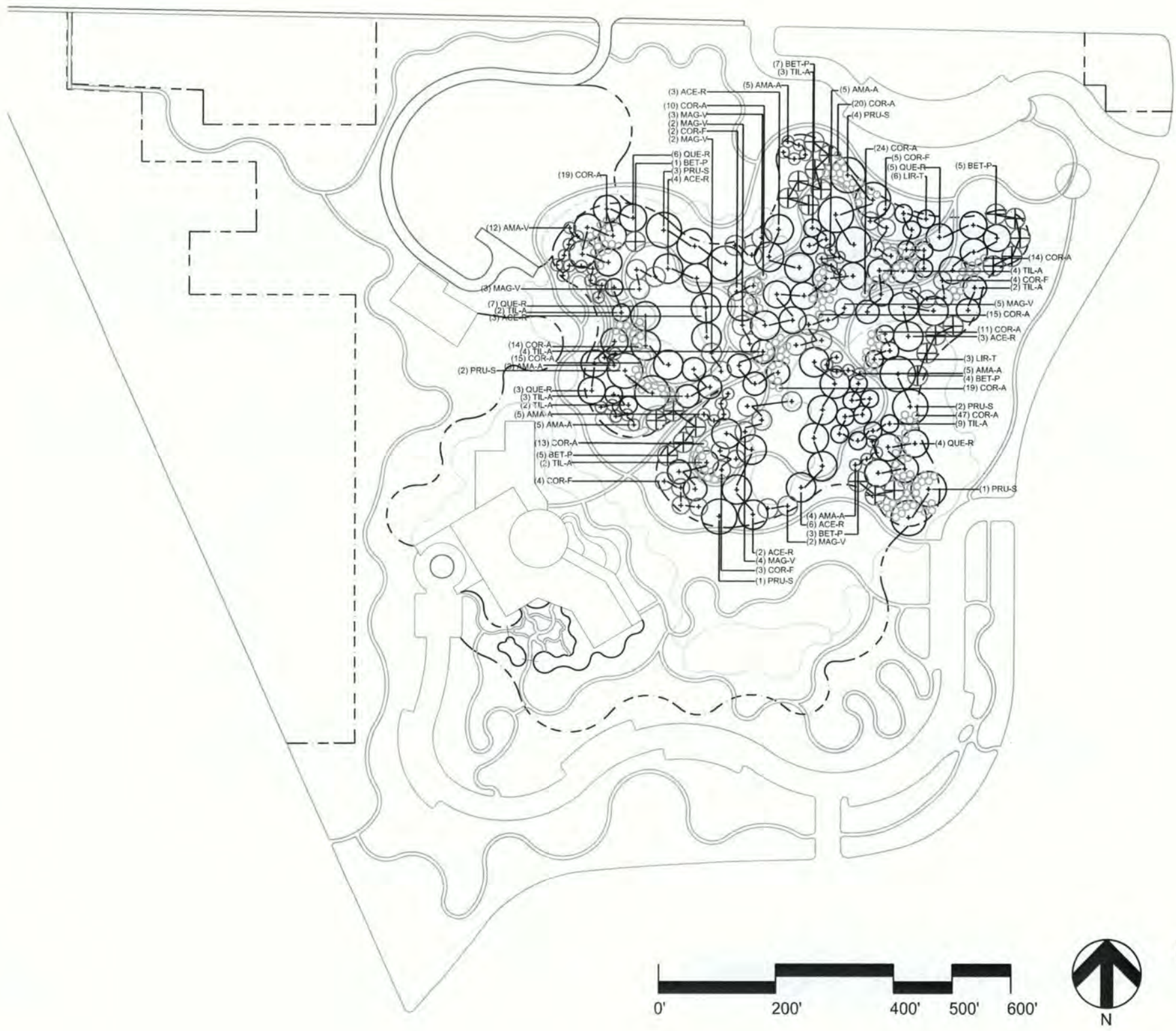
BEECH/MAPLE



Plant Matrix-Beech/Maple

Overstory							
Species	Height	Spread	Sun Requirements	Water Requirements	Animals	Color/Bloom Time	Notes
Quercus macrocarpa (Bur Oak)	60-80'	60-80'	Full Sun	Dry to Medium	Wood Ducks/White-Tailed Deer/Rabbits/Squirrels	Reddish Brown/Fall	Showing flowers
Acer saccharinum (Silver Maple)	50-80'	35-50'	Sun/Part Shade	Dry to Medium	Squirrels/Ducks	Yellow/Fall	Grows quickly
Fagus grandifolia (American Beech)	50-80'	40-80'	Sun/Part Shade	Medium	Birds/Chipmunks/Squirrels	Golden Bronze/Fall	Needs plenty of space
Acer saccharum (Sugar Maple)	40-80'	30-60'	Sun/Part Shade	Medium	White-Tailed Deer/Squirrels	Yellow Orange Red/Fall	
Betula populifolia (Grey Birch)	20-40'	10-20'	Sun/Part Shade	Medium to Wet	Birds/Insect Pollinators	Yellow/Fall	Short lifespan
Midstory							
Hamamelis virginiana (American Witchhazel	15-20'	15-20'	Sun/Part Shade	Medium	Deer/Birds	October-December	Long winter life
Lindera benzoin (Spicebush)	6-12'	6-12'	Sun/Part Shade	Medium	Spicebush Swallowtail Host/Birds	Yellow/Fall	
Grasses							
Elymus hystrix (Bottlebrush Grass)	2.5-3'	1-1.5'	Sun/Part Shade	Dry to Medium	Birds	Green/June-August	
Groundcover							
Plox divaricata (Wild Blue Phlox)	12"	10"	Part/Full Shade	Dry to Wet	Butterflies	Blue/March-May	
Ferns							
Adiantum pedatum (Maidenhair Fern)	1-2.5'	1-1.5'	Part/Full Shade	Medium	Lizards/Toads (shelter)		

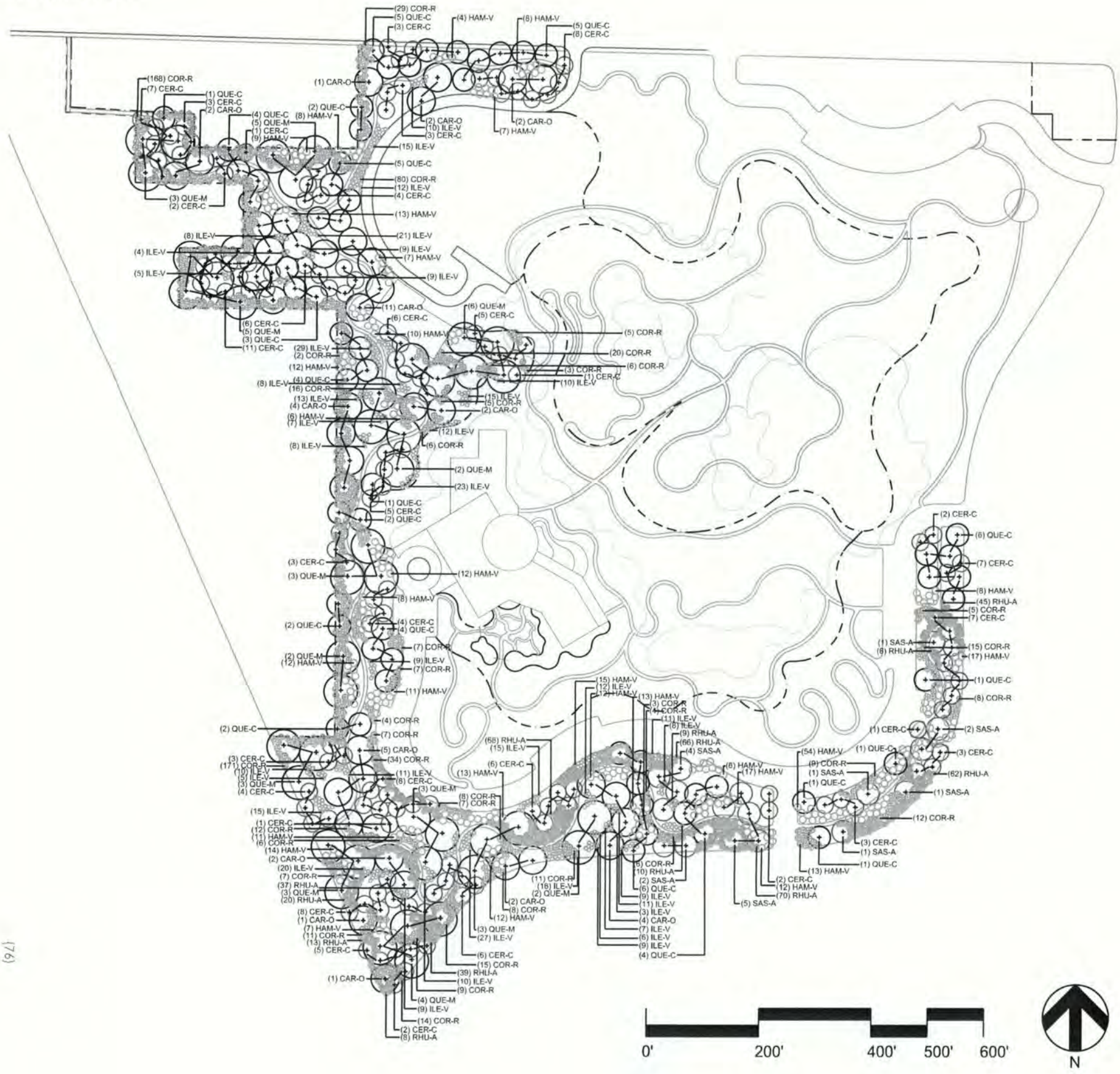
Figures 1.62-3- Beech/Maple planting plan and matrix



Planting Matrix-Maple/Basswood

Species	Height	Spread	Sun Requirements	Water Requirements	Animals	Color/Bloom Time	Notes
Overstory							
Acer rubrum (Red Maple)	40-70'	30-50'	Sun/Part Shade	Medium to Wet	Squirrels	Red/Fall	
Tilia americana (American Basswood)	50-80'	30-50'	Sun/Part Shade	Medium	Butterflies/Bees/Birds	Yellow/Fall	
Liriodendron tulipifera (Tulip Treee)	70-90'	40'	Full Sun	Medium	Deer/Rabbits/Hummingbirds/Birds/Squirrels	Yellow/May-June	Very important native species
Prunus serotina (Black Cherry)	50-80'	30-60'	Sun/Part Shade	Medium	Birds/Mammals	White/April-May	Poisonous to humans if ingested
Qurecus rubra (Red Oak)	60-75'	45'	Full Sun	Medium	Birds/Squirrels/Deer	Red/Fall	
Understory							
Cornus florida (Flowering Dogwood)	15-30'	15-30'	Sun/Part Shade	Medium	Birds/Butterflies	White/April-May	
Amalanchier arboreta (Serviceberry)	15-25'	15-25'	Sun/Part Shade	Medium	Birds	White/March-April	
Magnolia virginiana (Sweetbay Magnolia)	10-35'	10-35'	Sun/Part Shade	Medium to Wet	Squirrels/Birds	White/May-June	
Betula papyrifera (Paper Birch)	50-70'	35'	Sun/Part Shade	Medium	Deer/Hare/Birds/Hummingbirds	Yellow/Fall	Good for lots of nesting birds
Shrubs							
Corylus americana (American Hazelnut)	10-16'	8-13'	Sun/Part Shade	Medium	Squirrels/Deer/Birds	Yellow/Fall	Use as a hedge
Grasses							
Carex cepholaphora (Bracketed Oak Sedge)	1-2'	1-1.5'	Full Sun to Full Shade	Dry to Medium	Birds/Butterflies (Host)	Brownish/May	
Flowering Plants							
Allium cernuum (Nodding Wild Onion)	1-1.5'	.25-.5'	Sun/Part Shade	Dry to Medium	Butterflies/Hummingbirds/Birds	Purple/June-August	Excellent nectar source for native bees
Ferns							
Adiantum pedatum (Maidenhair Fern)	1-2.5'	1-1.5'	Part/Full Shade	Medium	Lizards/Toads (shelter)		

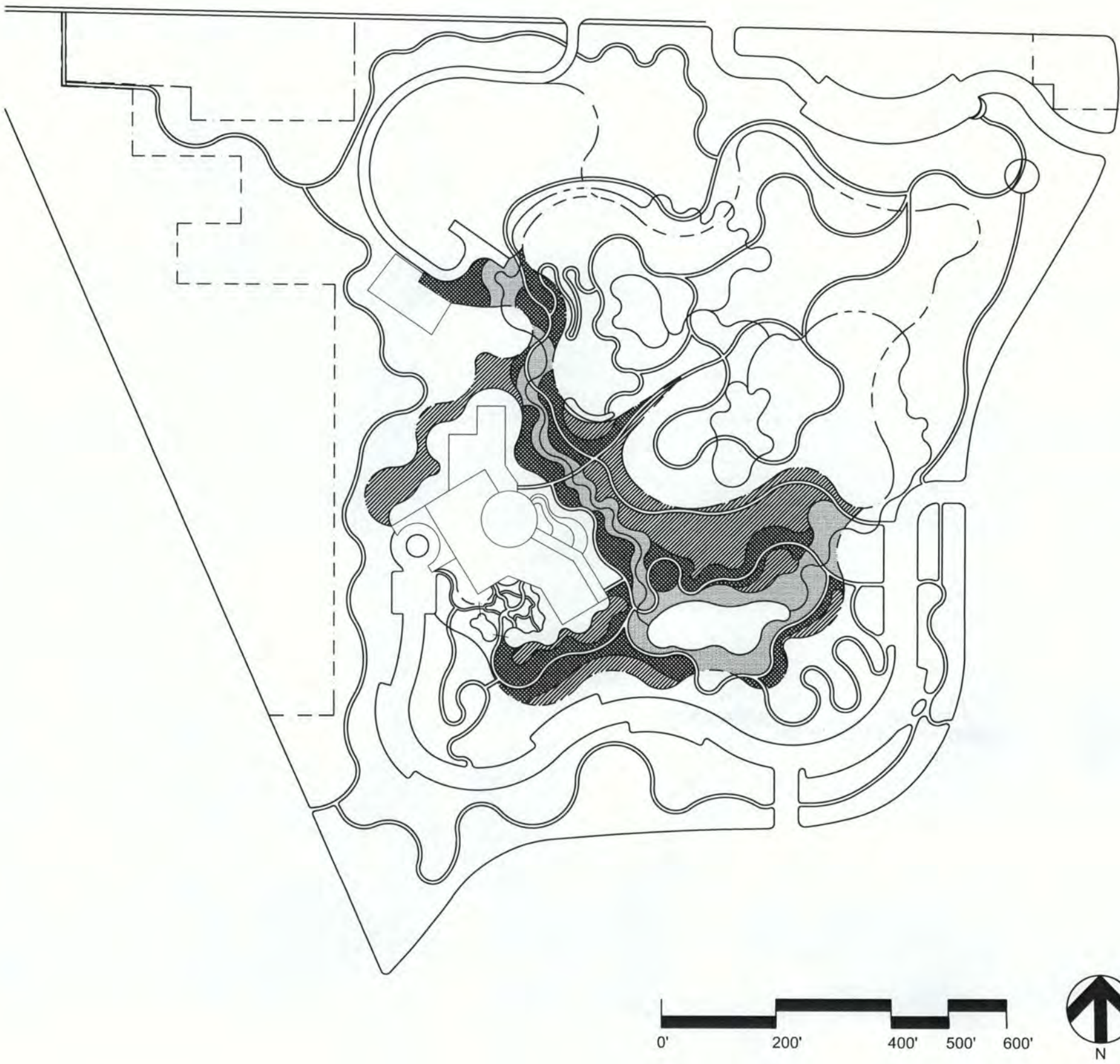
Figures 1.64-5- Maple/Basswood planting plan and matrix



Plant Matrix-Oak/Hickory

Species	Height	Spread	Sun Requirements	Water Requirements	Animals	Color/Bloom Time	Notes
Overstory							
Quercus macrocarpa (Bur Oak)	60-80'	60-80'	Full Sun	Dry to Medium	Wood Ducks/White-Tailed Deer/Rabbits/Squirrels	Reddish Brown/Fall	Showy flowers
Carya ovata (Shagbark Hickory)	70-90'	50-70'	Sun/Part Shade	Medium	Squirrels/Birds	Yellow/Fall	
Quercus coccinea (Scarlet Oak)	50-70'	40-50'	Full Sun	Dry to Medium	Birds/Squirrels/White-Tailed Deer	Scarlet/Fall	Great fall color
Midstory							
Hamamelis virginiana (American Witchhazel)	15-20'	15-20'	Sun/Part Shade	Medium	Deer/Birds	October-December	Long winter life
Cornus racemosa (Gray Dogwood)	10-15'	10-15'	Sun/Part Shade	Medium	Deer/Birds/Squirrels	White/May-June	Foliage prodivdes cover and nesting
Cercis canadensis (Eastern Redbud)	20-30'	25-35'	Sun/Part Shade	Medium	Birds/Early-Season Butterflies	Pink/April	Vibrant blooms
Sassafras albidum (Sassafras)	30-60'	25-40'	Sun/Part Shade	Medium	Birds/Butterflies (Host)	Yellow Purple Red	Ornamental blooms April-May
Shrubs							
Rhus aromatica "Gro-Low" (Gro-Low Fragrant Sumac)	1.5-2'	6-8'	Sun/Part Shade	Dry to Medium	Birds/Butterflies (Host)	Yellow/April	
Ilex verticilata (Winterberry)	3-12'	3-12'	Sun/Part Shade	Medium to Wet	Birds/Butterflies (Host)	Greenish-White/June-July	Provides habitat for birds
Grasses							
Carex cepholaphora (Bracketed Oak Sedge)	1-2'	1-1.5'	Full Sun to Full Shade	Dry to Medium	Birds/Butterflies (Host)	Brownish/May	
Flowering Plants							
Senecio obovatus (Round-leaf Ragwort)	1-1.5'	.5-1'	Sun/Part Shade	Medium to Wet	Butterflies	Yellow/April-June	Rocky wooded hillsides and rocky glades
Allium cernuum (Nodding Wild Onion)	1-1.5'	.25-.5'	Sun/Part Shade	Dry to Medium	Butterflies/Hummingbirds/Birds	Purple/June-August	Excellent nectar source for native bees
Ferns							
Adiantum pedatum (Maidenhair Fern)	1-2.5'	1-1.5'	Part/Full Shade	Medium	Lizards/Toads (shelter)		

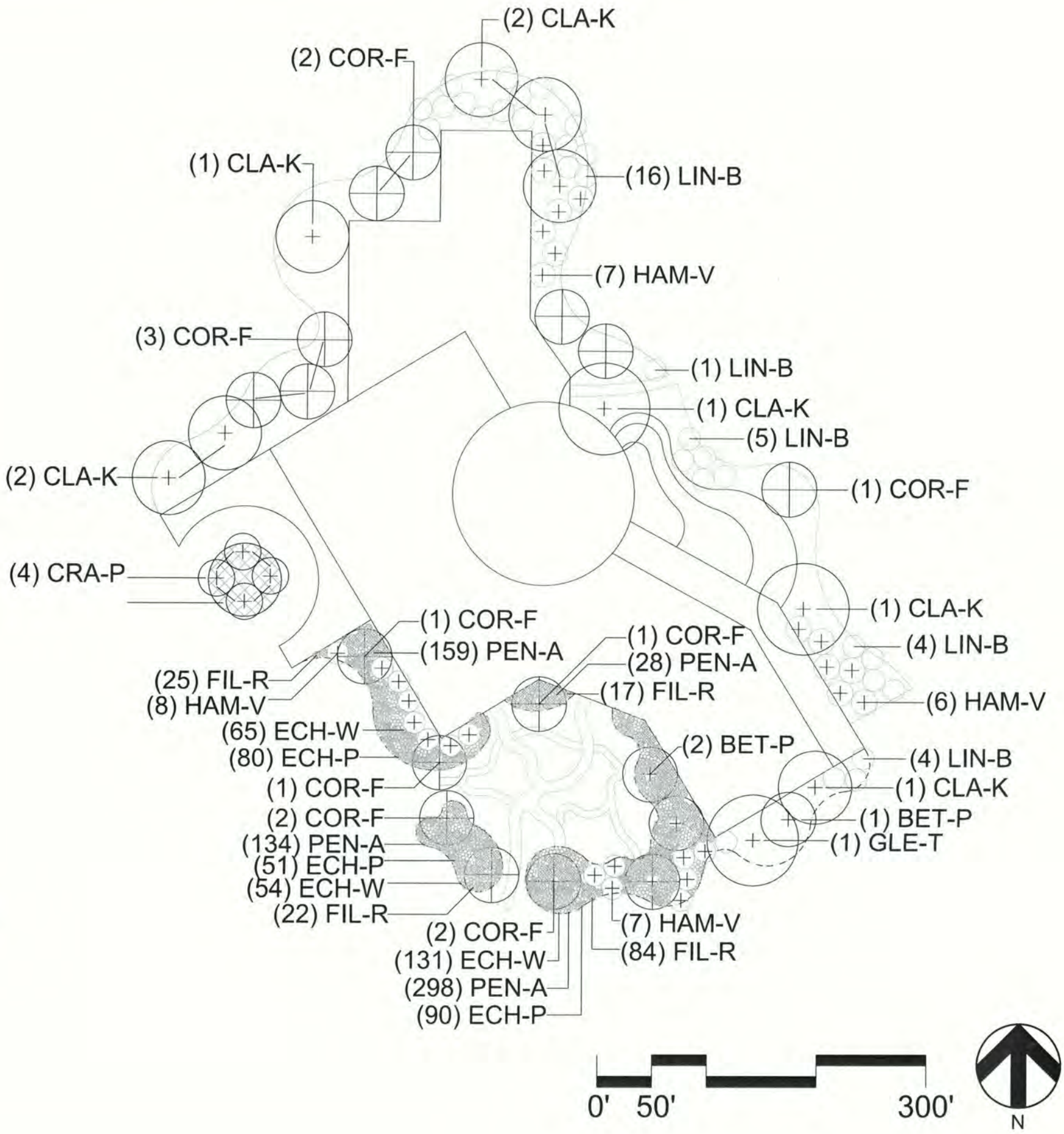
Figures 1.66-7- Oak/Hickory planting plan and matrix



Plant Matrix-Meadow

Species	Height	Spread	Spread Pattern	Bloom Season	Bloom Description	Sun Requirements	Water Requirements	Category	Animals	Good Winter/Fall/Spring	Notes
Grasses/Sedges											
Carex bromoides (Brome Hummock Sedge)	1-2'	.5-1'	Clump	April-May	Greenish	Sun/Part Shade	Medium to Wet	Filler	Birds		
Carex stricta (Tussock Sedge)	2-3'	1-2'	Mounded Clump	June	Green/Tan	Sun/Part Shade	Medium to Wet	Filler	Birds/Turtles/Butterfly Host		Edge of water
Carex bicknellii (Copper Shouldered Oval Sedge)	1-3'	1'	Dense Clump	June-July	Brown/Bronze	Sun/Part Shade	Medium to Wet	Filler	Birds (Sparrows)		
Calamagrostis canadensis (Blue Joint Grass)	3-5'	2'	Clump	June-August	Greenish	Sun to Full Shade	Medium	Background	Birds		Fine textured (pathway or near water)
Bouteloua curtipendula (Sideoats Grama)	1.5-2.5'	1.5-2'	Dense Clump	July-August	Purplish	Full Sun	Dry to Medium	Groundcover	Birds	Yes (fall)	Main meadow plant
Panicum virgatum 'North Wind' (Switchgrass)	3-6'	2-3'	Clump	July-February	Pinkish	Sun/Part Shade	Medium to Wet	Fillet	Birds	Yes (fall/winter/spring)	YES; so pretty ;good for winter
Sporobolus heterolepis	2-3'	2-3'	Clump	August-October	Pink and brown	Full Sun	Dry to Medium	Ground Cover	Birds	Yes (winter)	Use along pathway
Flowering Plants											
Baptisia alba (White False Indigo)	2-4'	2-2.5'	Slow expanding clumps	April-May	White	Sun/Part Shade	Dry to Medium	Accent	Butterflies		
Zizia aurea (Golden Alexanders)	2-3'	1.5-2'	Small colonies	May	Yellow	Sun/Part Shade	Medium	Accent	Butterflies (Host and Nectar)		Secondary meadow ring
Anemone canadensis (Meadow Anemone)	1-2'	2-3'	Aggressive Colony	May-June	White	Sun/Part Shade	Medium to Wet	Groundcover			Aggressive;use near water and sun
Asclepias incarnata (Swamp Milkweed)	3-5'	2-3'	Clumping	June-July	Pink/Rose	Sun/Part Shade	Medium to Wet	Accent	Butterflies, Bees, Hummingbirds		Use near water, but not edge
Solidago juncea (Early Goldenrod)	3'	2'	Clumping	July-September	Yellow	Sun/Part Shade	Dry to Medium	Accent	Butterflies/Bees/Moth (Host)/Birds		
Boltonia asteroides (Thousand-Flower Aster)	3-6'	2-4'	Spreading rhizomes	July-September	White	Sun/Part Shade	Medium to Wet	Accent	Butterflies		Strong vertical stems in sun
Rudbeckia subtomentosa (Sweet Coneflower)	3-5'	1-2'	Clumping	July-October	Yellow	Sun/Part Shade	Medium to Wet	Accent	Butterfly (Nectar and Host)/Bees/Birds	Yes (fall, summer,spring)	Main Flower/leaves conehead behind
Lobelia cardinalis (Cardinal Flower)	2-5'	1-2'	Clumping	August-September	Red	Sun to Full Shade	Medium to Wet	Accent	Butterflies/Hummingbirds		Offers pops of color
Aster puniceus (Purple Stemmed Aster)	4-8'	2-3'	Clumping	August-October	Light Blue	Sun/Part Shade	Medium to Wet	Accent	Butterflies	Yes (Fall)	Tall enough for mid-meadow
Eutrochium purpureum (Joe Pye Weed)	5-7'	2-4'	Clumping	July-September	Light Pink	Sun/Part Shade	Medium	Accent	Butterflies	Yes (Spring)	Feathery and SO PRETTY
Filipendula rubra (Queen of the Prairie)	6-8'	3-4'	Clumping	June-August	Light Pink	Sun/Part Shade	Medium to Wet	Accent	Butterflies		SAME
Liatris spicata (Blazing Star)	2-4'	.75-1.5'	Clumping	July-August	Purplish	Full Sun	Medium	Accent	Butterflies/Birds	Yes	
Lobelia siphilitica (Great Blue Lobelia)	2-3'	1-1.5'	Clumping	July-September	Purplish	Sun/Part Shade	Medium to Wet	Accent	Butterflies	Yes	Can tolerate dry conditions

Figures 1.68-9- Meadow planting plan and matrix



Planting Matrix-Visitor Center							
Overstory							
Species	Height	Spread	Sun Requirements	Water Requirements	Animals	Color/Bloom Time	Notes
Cladrastis kentukea (American Yellowwood)	30-50'	40-55'	Full Sun	Medium		White/May	
Gleditsia triacanthos v. inermis (Thornless Honeylocust)	30-70'	30-70'	Full Sun	Medium	Birds/Mammals	Golden/Fall	Thornless variety
Midstory							
Crataegus phaenopyrum (Washington Hawthorn)	25-30'	25'	Full Sun	Medium	Birds/Mammals/Bees	White/June	Thorns
Magnolia acuminata (Cucumber Magnolia)	40-70'	20-35'	Full Sun	Medium	Birds/Mammals/Deer	Greenish-Yellow/April-May	Long time to produce blooms
Cornus florida (Flowering Dogwood)	15-30'	15-30'	Sun/Part Shade	Medium	Birds/Butterflies	White/April-May	
Shrubs							
Lindera benzoin (Spicebush)	6-12'	6-12'	Sun/Part Shade	Medium	Spicebush Swallowtail Host/Birds	Yellow/Fall	
Vibernum dentatum (Arrowwood vibernum)	6-15'	6-15'	Sun/Part Shade		Red Admiral, Eastern Comma and Question Mark Butterflies/Birds/Spring Azure Butterfly and Hummingbird Moth Host	Creamy White/May-June	
Groundcover							
Geranium sanguineum (Bloody Cranesbill Geranium)	.75-1.5'	1-1.5'	Part/Full Shade	Medium		Pinkish/May-June	
Grasses							
Carex cepholaphora (Bracketed Oak Sedge)	1-2'	1-1.5'	Full Sun to Full Shade	Dry to Medium	Birds/Butterflies (Host)	Brownish/May	

Planting Matrix-Children's Garden							
Overstory							
Species	Height	Spread	Sun Requirements	Water Requirements	Animals	Color/Bloom Time	Notes
Gleditsia triacanthos v. inermis (Thornless Honeylocust)	30-70'	30-70'	Full Sun	Medium	Birds/Mammals	Golden/Fall	Thornless variety
Midstory							
Cornus florida (Flowering Dogwood)	15-30'	15-30'	Sun/Part Shade	Medium	Birds/Butterflies	White/April-May	
Betula papyrifera (Paper Birch)	50-70'	35'	Sun/Part Shade	Medium	Deer/Hare/Birds/Hummingbirds	Yellow/Fall	Good for lots of nesting birds
Hamamelis virginiana (American Witchhazel)	15-20'	15-20'	Sun/Part Shade	Medium	Deer/Birds	October-December	Long winter life
Flowering Plants							
Filipendula rubra (Queen of the Prairie)	6-8'	3-4'	Sun/Part Shade	Medium to Wet	Butterflies	Pink/June-August	Fairy Dust
Echinacea purperea (Purple Coneflower)	2-5'	1.5-2'	Sun/Part Shade	Dry to Medium	Birds/Butterflies/Hummingbirds	Purple/June-August	
Echinacea purperea 'White Swan' (White Swan Coneflower)	2-3'	18"	Sun/Part Shade	Dry to Medium	Birds/Butterflies/Hummingbirds	White/July-September	
Grasses							
Pennisetum alopecuroides 'Little Bunny' (Little Bunny Fountaingrass)	1-1.5'	1.5-2'	Sun/Part Shade	Medium to Wet	Birds	Whitish/August-September	Winter Interest
Carex cepholaphora (Bracketed Oak Sedge)	1-2'	1-1.5'	Full Sun to Full Shade	Dry to Medium	Birds/Butterflies (Host)	Brownish/May	

Figures 1.70-2- Visitor's center and children's garden planting plan and matrix

Figure 1.73- Areas in pink are denoting vegetated protective zones

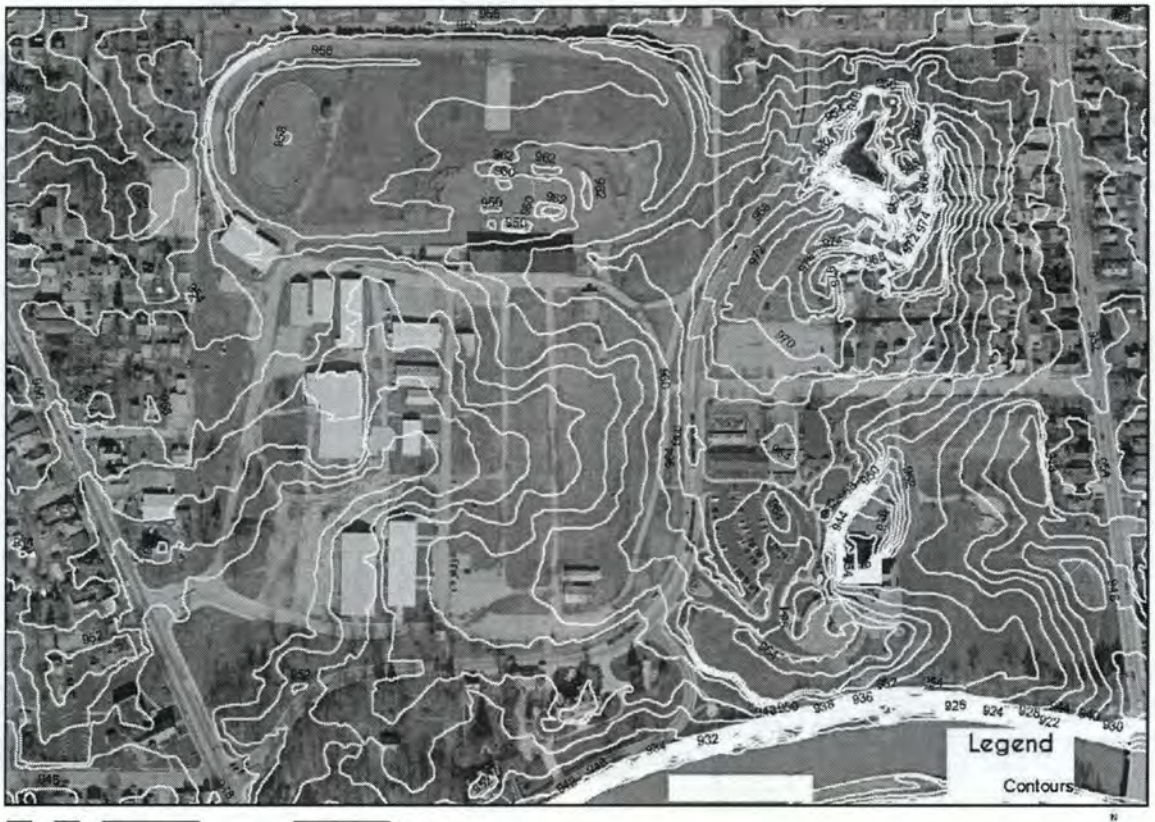


Figure 1.74-The original contour signature of the fairgrounds

CHANGE OVER TIME

Figures 1.75-8-Diagrams showing tree degradation on the site over time

1974

1982

1992

2004

4

CENTRE

Scale 2 Inches to the Mile.

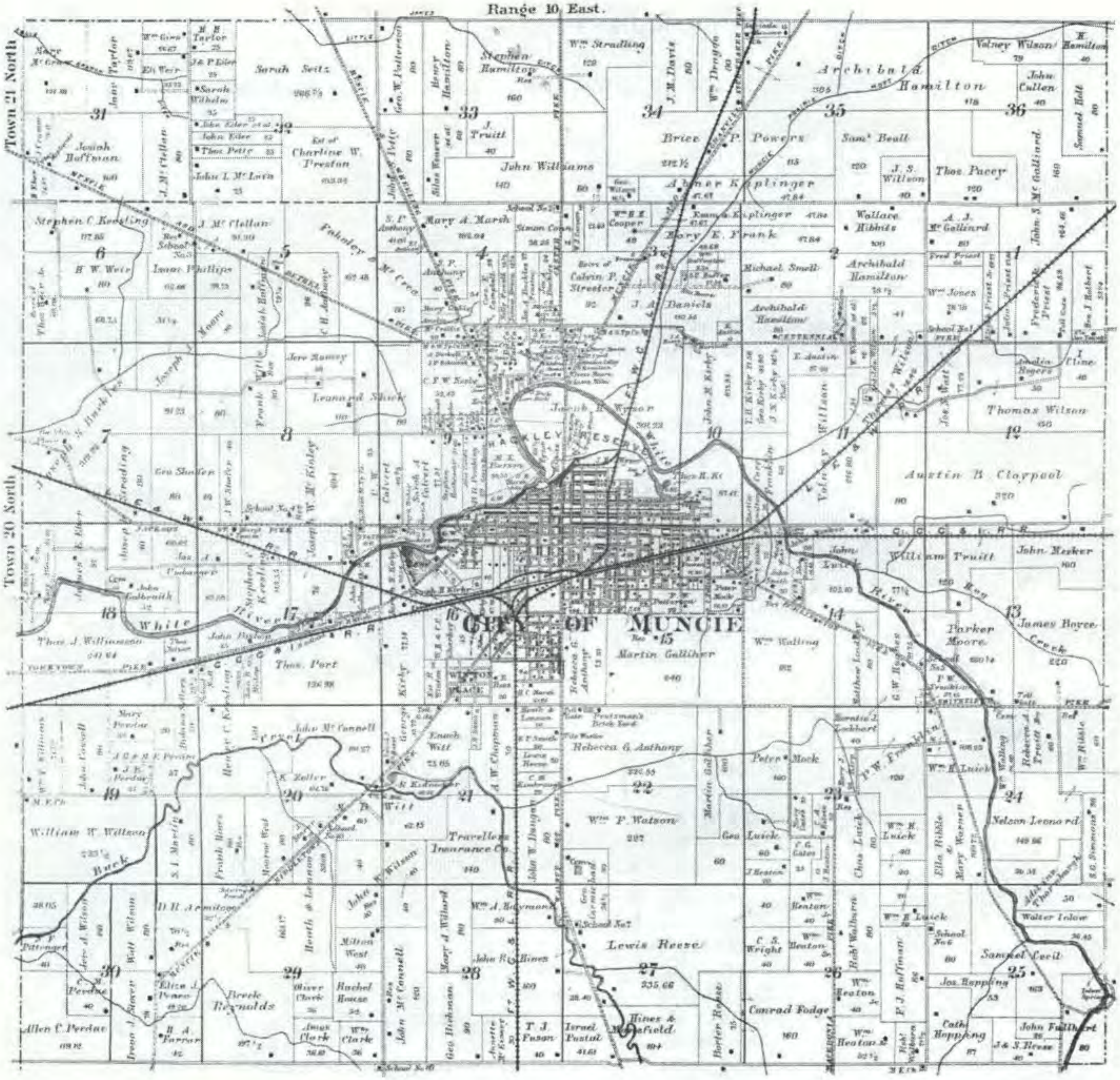


Figure 1.79- Map from early 1900s denoting the fairgounds

Delaware County, Indiana

UfuA—Urban land-Millgrove complex, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 5jpp
Elevation: 600 to 1,250 feet
Mean annual precipitation: 36 to 43 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 45 percent
Millgrove and similar soils: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Outwash plains

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Other vegetative classification: Trees/Timber (Woody Vegetation)

Description of Millgrove

Setting

Landform: Depressions on outwash plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy outwash

Typical profile

Ap - 0 to 8 inches: silty clay loam
AB - 8 to 15 inches: silty clay loam
Btg - 15 to 32 inches: clay loam
2BCg - 32 to 48 inches: gravelly loam
2Cg - 48 to 80 inches: stratified fine sand to gravelly sandy loam to very gravelly loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Figure 1.80- Web soil survery for UfuA soil classification

Delaware County, Indiana

UemB—Urban land-Fox complex, 1 to 6 percent slopes

Map Unit Setting

National map unit symbol: 5jpm
Elevation: 600 to 1,250 feet
Mean annual precipitation: 36 to 43 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 45 percent
Fox and similar soils: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Terraces
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Linear

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Other vegetative classification: Trees/Timber (Woody Vegetation)

Description of Fox

Setting

Landform: Terraces
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy outwash over sandy and gravelly outwash

Typical profile

Ap - 0 to 10 inches: loam
Bt1 - 10 to 19 inches: clay loam
Bt2 - 19 to 31 inches: gravelly sandy clay loam
2C - 31 to 80 inches: stratified extremely gravelly coarse sand to very gravelly coarse sand to sand

Properties and qualities

Slope: 1 to 6 percent

Figure 1.81- Web soil survery for UemB soil classification

Delaware County, Indiana

UdmA—Urban land-Blount-Pewamo complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 5jpl
Elevation: 600 to 1,250 feet
Mean annual precipitation: 36 to 43 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 45 percent
Blount and similar soils: 20 percent
Pewamo and similar soils: 15 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Till plains

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Other vegetative classification: Trees/Timber (Woody Vegetation)

Description of Blount

Setting

Landform: Till plains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over clayey till

Typical profile

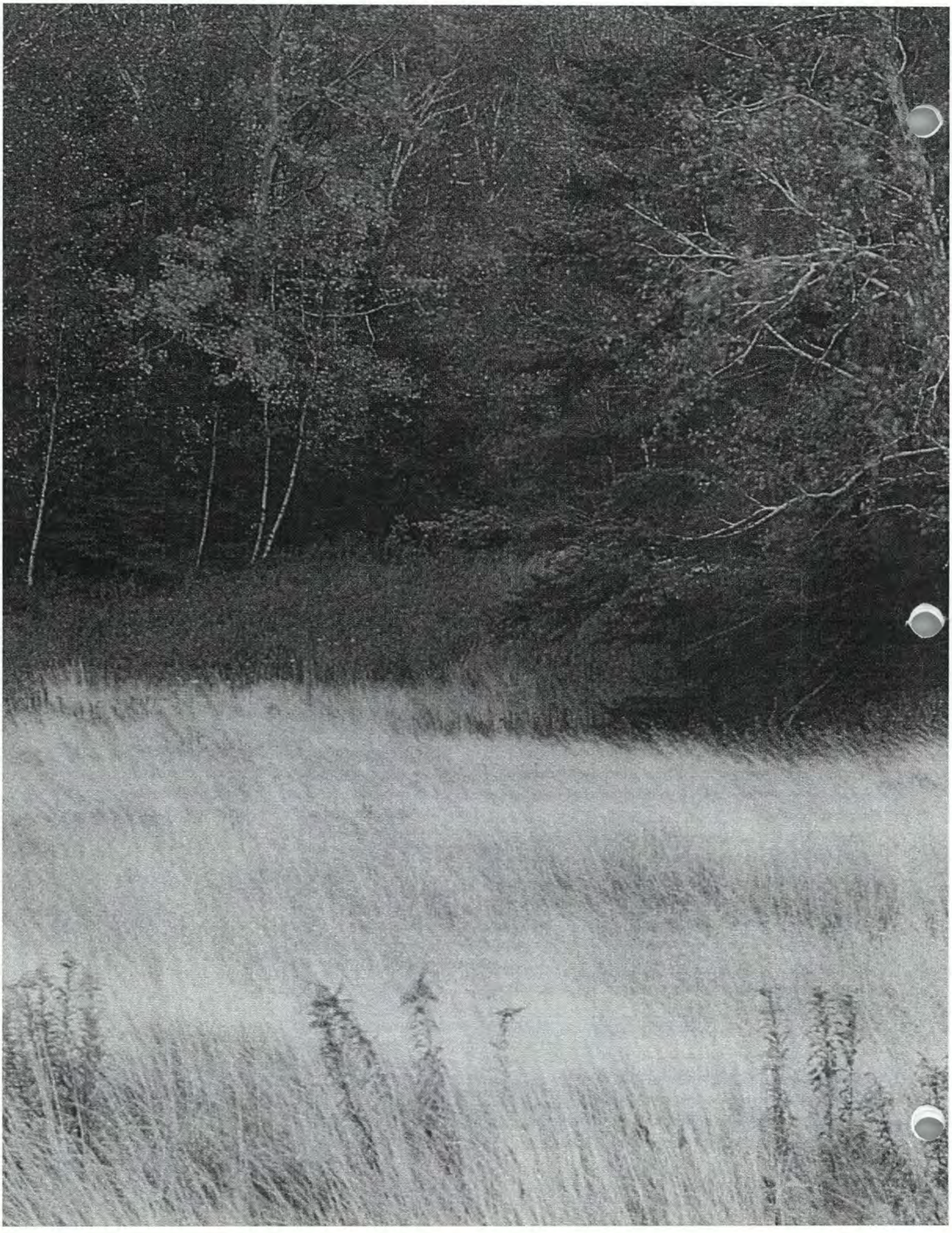
Ap - 0 to 7 inches: silt loam
Bt - 7 to 23 inches: silty clay
BCtg - 23 to 30 inches: silty clay loam
CBd - 30 to 42 inches: clay loam
Cd - 42 to 80 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 30 to 48 inches to densic material
Natural drainage class: Somewhat poorly drained
Runoff class: Medium

Figure 1.82- Web soil survery for UdmA soil classification

LIST OF FIGURES



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